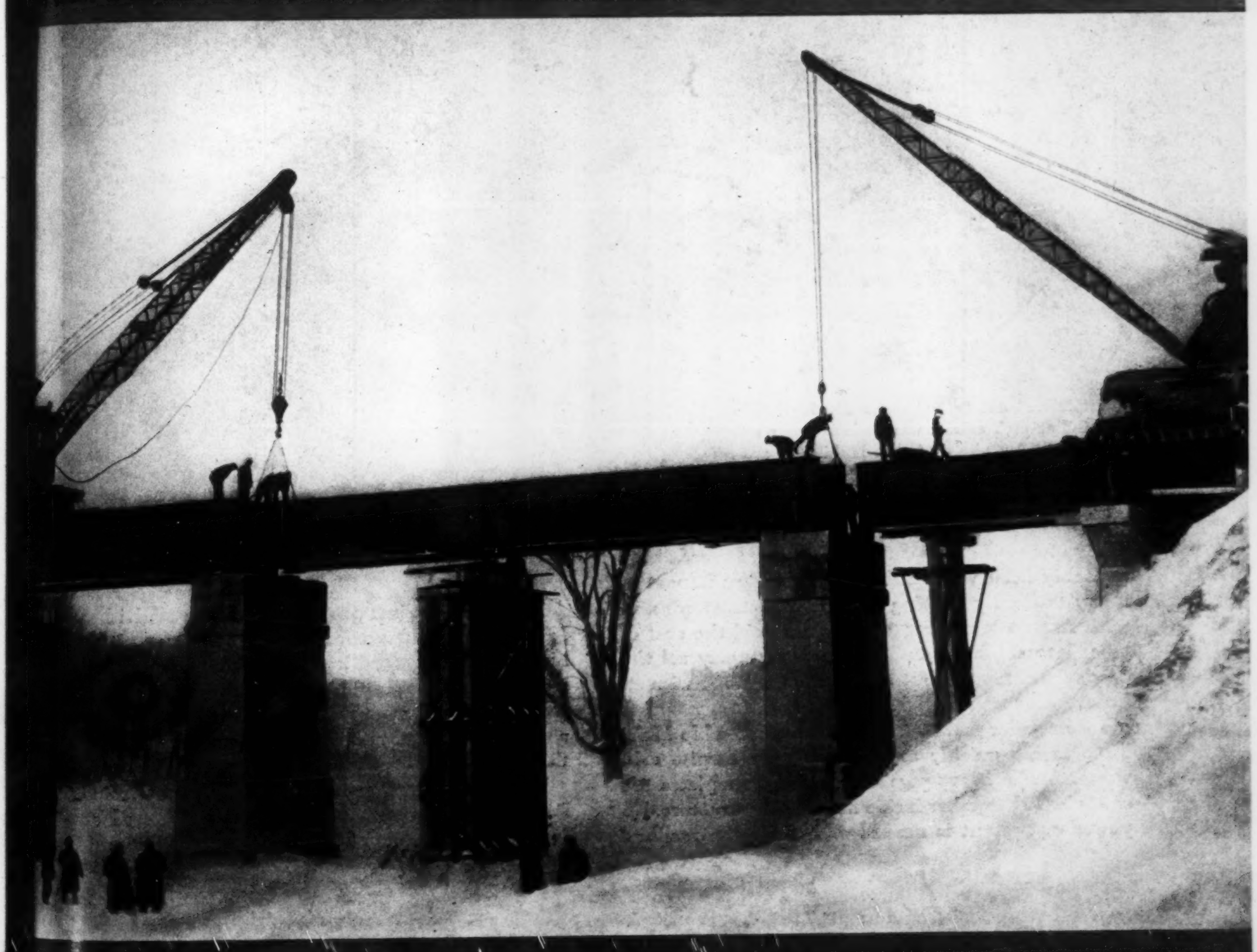
ENGINEERING CONSTRUCTION WEEKLY

ENGINEERING NEWS-RECORD

DEC 26 1939

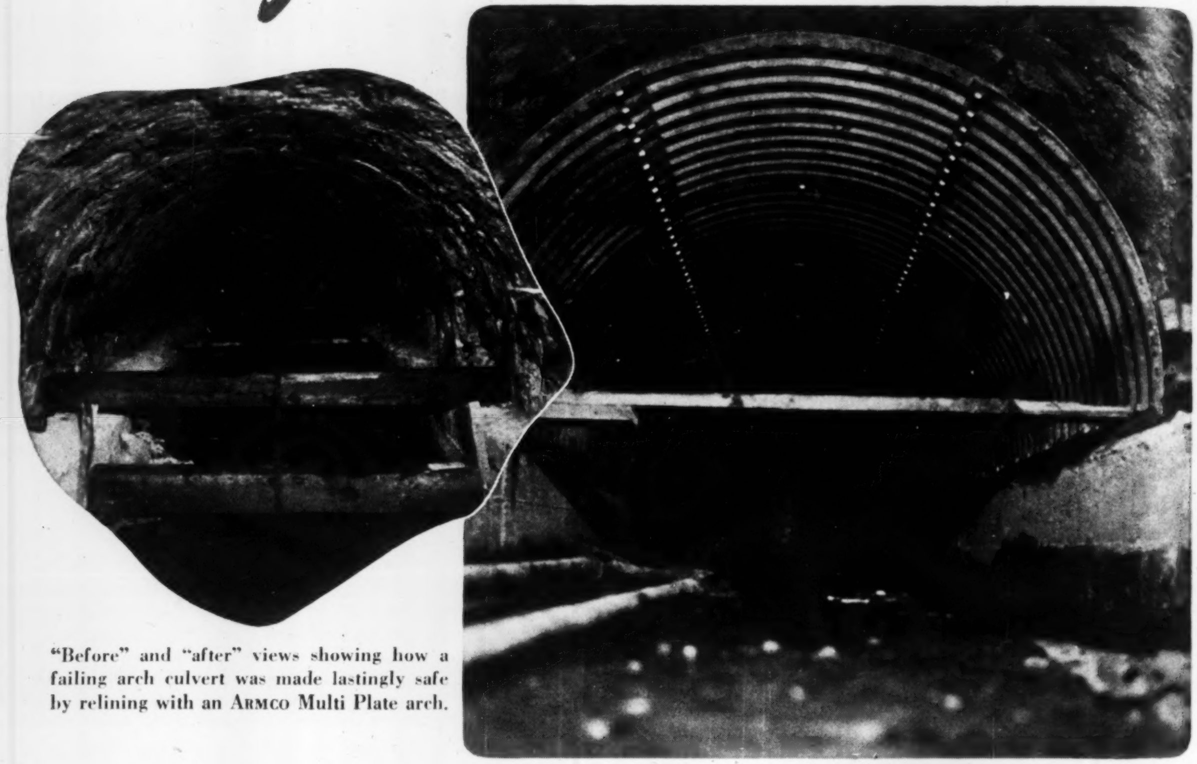
DECEMBER 21, 1939

g girders of the Nith River Bridge in Ontario to new piers made of steel H-piles.



N THIS ISSUE: Divided Highway Design • Close Coordination Speeds Housing Project • Double Filtration at Lawrence • Queens Midtown Tunnel • teel Pile Piers for Railroad Bridges • For Full Contents See Page 25.

END THE WORRY OF "Falling Arches"



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THIS WEEK

● Separating opposing lanes of traffic on major highways now is accepted as the best means for reducing accidents and increasing capacity. What types of design are being developed for these highways are the subject of a series of articles beginning in this issue. The current article relates to cross profile and dimensions.

● Contractors will find pertinent information on how a large building operation can be speeded by close coordination of operations in the account of the Buffalo housing project on p. 44.

● Engineers whose experience goes back to the days of wooden bridges when pier building often was simplified by making a cluster of closely driven wooden piles serve both as foundation and pier shaft will find close similarity in the Canadian National Ry. bridge pier described on p. 48. Piers of this type have been built on this side of the border recently, but of lesser magnitude.

● Quite appropriately, Lawrence, Mass., the starting point for so much that has been done in sanitary engineering, is the place where "double filtration" is being used to make a highly polluted water palatable.

● New York is driving its first vehicle tunnel under the East River. This issue tells what led up to a decision to build a tunnel instead of a bridge. A subsequent issue will tell of the difficult tunnel driving work.

● Engineers who plan and work for big projects that are a long time in reaching actual construction too often are forgotten. For that reason the article "Men Behind Filtration in Chicago" stands out as an unusual record.

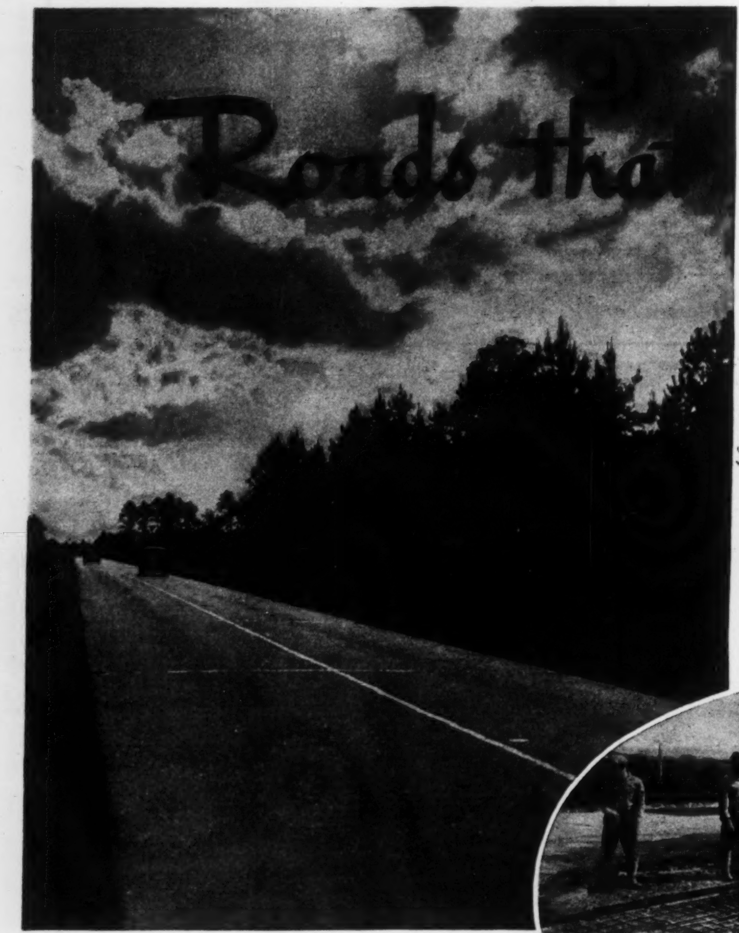
THINGS TO COME

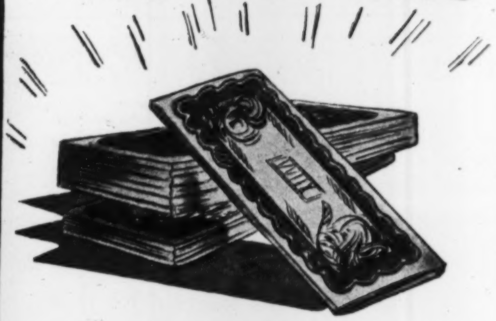
IF WAR should come are we ready with roads?

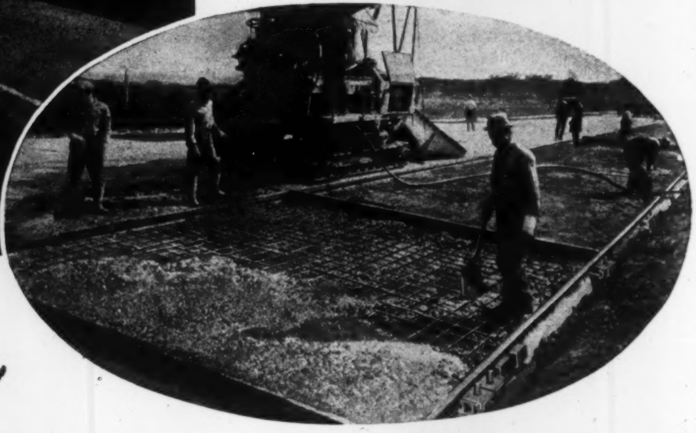
The Annual Highway Number January 18 will answer this vital question in a group of four articles on "Roads for National Defense," which will clarify the War Department viewpoint and present the fundamental objectives and plans for making our peacetime road system an efficient system for national defense.

The issue also will give state-by-state accounts of mileage and expenditures chalked up in 1939 and estimated for 1940. And every reader will be interested in an 8-page rotogravure pictorial of a quarter-century advance in road building.

THAT "Send me some wire rope" is not the proper approach to the purchase of this common construction product is evident from an article on "Sheave and Drum Design As a Measure of Wire Rope Economy" to be published in the January 4 issue.







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NEWS
ENGINEERING NEWS-RECORD

Volume 123 DECEMBER 21, 1939 Number 25

Louisiana Highway Body Sued for $1,000,000

A suit for $1,000,000 plus interest and costs has been filed against the Louisiana State Highway Commission by the Kansas City Bridge Co., contractors for the substructure of the $10,000,000 bridge being built across the Mississippi River at Baton Rouge. Suit has been started in the federal district court, the Kansas City Bridge Co. claiming that the commission through delays and changes in the plans caused expenses beyond terms of the contract.

The company was awarded on June 19, 1937, a contract for $2,321,000 for construction of the six main river piers.

• • •

Labor Trouble Delays Sepulveda Dam Bidding

A dispute over the difference between union scales and "prevailing wages" as determined by Secretary of Labor Perkins has caused a delay of one week in the opening of bids for Sepulveda Dam, an earth-fill structure to be built on the Los Angeles River by the U. S. Engineers. On Dec. 14, the original bid date, a hearing was held before John Wheeler, U. S. labor referee. The unionists claimed that the minimum wages as defined in the specifications were too low and District Engineer Edwin C. Kelton contended that "prevailing wages" were the proper basis for the minimum. The outcome was postponing the bid opening until Dec. 21; and the Secretary of Labor, upon the recommendations of Col. Kelton, modified certain minimum scales.

• • •

School Named for Engineer

An elementary school at Emeryville, Calif., has been named the Ralph S. Hawley school in honor of the late Ralph S. Hawley, who was city engineer of Emeryville for 18 years.

NEW ENGINEERING DEAN AT GEORGE WASHINGTON

FREDERICK M. FEIKER, executive secretary of the American Engineering Council, has resigned to become dean of the School of Engineering at George Washington University. Feiker graduated from Worcester Polytechnic Institute in 1904 and was with the A. W. Shaw publications in Chicago for a number of years, later joining the McGraw Publishing Co. as editor of *Electrical World*, later becoming editorial director of the McGraw-Hill publications. Feiker left the McGraw-Hill organization in 1920 to go to the Department of Commerce. Subsequently he served as managing director of the Associated Business Papers. He went to American Engineering Council in 1934.

Henry Hudson Bridge Used by 29,000,000 Cars

Last week and a day before the bridge was to be three years old, the 29,000,000th automobile was driven over the Henry Hudson Bridge at New York City. Statistics show that 6,240,000 cars used the bridge the first year, 10,160,000 the second and 12,600,000 the third.

Engineers Begin Salary Study

Civil, mechanical and chemical groups join in study of pay and classification of engineers

A broad study of compensation and classification of engineers and engineering assistants was inaugurated at New York on Dec. 15 to determine whether it will be possible to develop schedules that can be accepted by a large part of the engineering profession as the basis for determining what are fair salaries and proper classifications of work in any region for all major classes of engineering employment. Such a

(*Continued on p.* 28)

• • •

Byron Houghtaling Dies, New York Subway Engineer

Byron F. Houghtaling, division engineer for the New York Board of Transportation in charge of construction of the $36,000,000 Sixth Ave. subway link, died of a heart attack Dec. 19 while addressing the Municipal Engineers Society. Houghtaling was born in 1887 at Athens, N. Y. After graduation from Catskill Academy, he entered the employ of New York state as a surveyor in 1907. Except for one year, 1918, when he was with the du Pont Co., he was engaged in subway work in New York City from 1911 to the time of his death.

• • •

PWA Rejects McNaughton As Grand River Dam Head

Public Works Administration has disapproved appointment of Ray McNaughton as manager of the $20,000,000 Grand River Dam project in northeastern Oklahoma. When R. V. L. Wright, former manager, resigned recently, the Grand River Authority board suggested the appointment of McNaughton, who is chairman of the Grand River Authority.

Sunshine Dam Completed In Wyoming

The Sunshine Dam of the Greybull Valley Irrigation District, a million dollar project near Greybull, Wyo., has been completed, according to H. C. Avery, resident engineer inspector for the PWA. The work was a PWA project with 30 per cent of the cost being an outright gift from the federal government.

• • •

Engineers Study Salaries

(Continued from p. 27)

schedule was recently adopted by the American Society of Civil Engineers for a limited number of engineering positions; the American Association of Engineers also has such a schedule, as do some of the state societies, but nearly all apply to civil engineers. The study begun last week will explore the possibility of harmonizing these schedules and amplifying them to cover other fields.

Attending the conference were representatives of the American Society of Civil Engineers, the American Society of Mechanical Engineers, the Institute of Consulting Engineers, the American Institute of Chemical Engineers, the National Society of Professional Engineers, the American Association of Engineers and the Society for the Promotion of Engineering Education. The American Institute of Electrical Engineers and the American Institute of Mining and Metallurgical Engineers declined the invitation to participate.

Existing schedules of engineering positions and salaries were discussed as were available studies of compensation of employed engineers and it was decided that the first step to be taken should be an attempt to harmonize the existing schedules, which are largely civil engineering. Subsequently a study will be made of other fields to see what possibilities there are for developing schedules in those fields that will be in harmony with those in the civil engineering field for corresponding training and experience. Attention is to be centered on the junior positions as it is recognized that approved schedules can be most useful in lower paid classifications.

• • •

$3,000,000 To Be Spent By Indiana on Bridges

The Indiana State Highways Commission has announced that in 1940 $3,000,000 will be spent on replacing old bridges. This year 69 bridges have been built.

Toronto Citizens to Vote On $11,200,000 of Work

Citizens of Toronto, Ont. will vote January 1, on the expenditure of $11,200,000 for civic improvements. Two projects are being voted upon. The first is a $5,600,000 traffic artery to connect Jarvis Street with Mount Pleasant Road, and improved street railway and traffic arteries from Dupont Street to St. Clair Ave., and the second a $5,600,000 sewage treatment plant.

The question of treatment of Toronto's sewage has been a matter of controversy for many years; negotiations having culminated in a recent inquiry by a board of expert engineers, all but one of whom recommended a complete treatment plant at an estimated cost of $9,500,000 (*ENR*, Oct. 12, 1939, page 453). A proposal before the voters is a compromise suggested by the mayor, whereby the first stage of a plant will be constructed to allow partial treatment pending completion of the entire work. The Minister of Health has warned the Toronto city council that the provincial authority will not accept the proposed scheme or approve it unless the treatment plant to be built is to be part of a complete treatment system.

Plans for the street work were prepared for the city's engineering staff.

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Blaine S. Britton Photos

TWIN TUBES SUNK IN CHICAGO RIVER FOR STATE ST. SUBWAY

The twin steel tubes, 200 ft. long, that will form the underwater link in the State St. section of Chicago's subway system were sunk into a prepared trench in the Chicago River bottom on schedule, Dec. 13. Merritt-Chapman & Scott Corp., contractor on the river section, prepared the tubes for sinking the previous day while they were moored alongside the river bank. Precast concrete blocks were placed on top of the steel section until it was submerged, and just below the stage of buoyancy. Then two barges, equipped with steam winches, were floated over the tubes, and their winch lines fastened in such a manner that the tubes were supported by the barges. High steel frames at each end of the tubes served as survey guides.

Early on the morning of Dec. 13 the whole assembly was maneuvered to position across the river at the site; river traffic was suspended for the day. By slowly lowering away on the winch lines and adding more ballast in the form of concrete blocks, the tubes were landed on the bottom. The lowering process took about three hours. The next day tremie concrete was poured around the steel tubes to anchor them in place. Connections to the land sections will be built in cofferdams.

The left photograph shows the tube afloat, just before it was submerged. One of the concrete weight blocks can be seen at the extreme left. The other view shows the assembly in place at start of sinking.

Ernest Seeman is project manager for Merritt-Chapman & Scott; E. L. Olsen is superintendent.

WASHINGTON HIGHLIGHTS

Special reports by Paul Wooton

THE U. S. SUPREME COURT will hear arguments Jan. 29 on whether the state of Oklahoma may bring suit to halt construction of the Denison Dam —a $48,000,000 federal flood control and power project. If the court accepts the case, it will constitute the first high court test of constitutionality of the 1938 flood control act.

THE WAR DEPARTMENT last week asked for competitive bids on $9,432,500 worth of barracks construction in the Canal Zone (*ENR*,Dec.14,1939,p.1). The baracks are to be located at Albrook Field; the Panama Airbase; Forts Kobbe, Sherman, and Davis; and the Mount Hope and Corozal military reservations.

• • •

Large Road Program Under Way in Minnesota

In spite of a $1,625,000 deficit carried over from 1938 and paid from 1939 revenues, the Minnesota State Highway Department during the past year placed under contract 907 miles of trunk highway improvements and through maintenance forces has reconditioned and brought up to standard specifications 3,200 miles of bituminous and gravel surface roads.

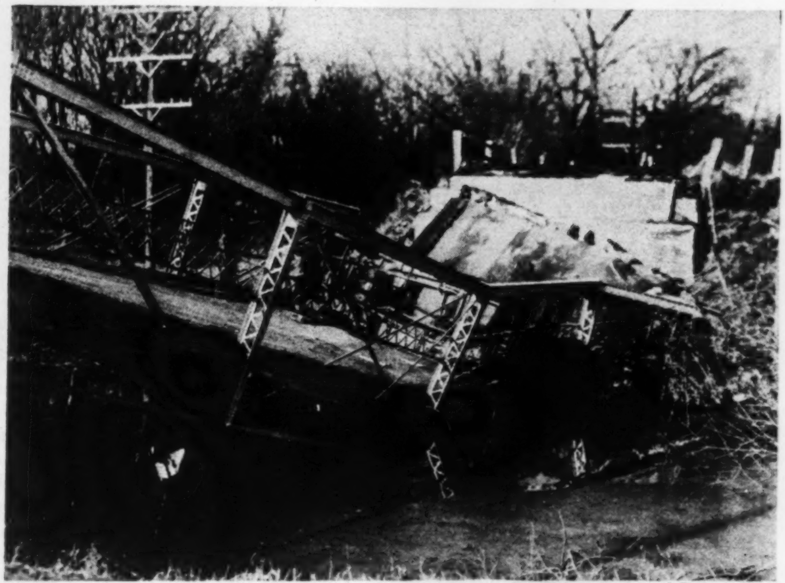
Awards between Jan. 1 and Nov. 15 totalled $4,980,000, somewhat under the $5,269,000 total for 1938. Federal aid this year amounted to $3,784,000 compared with $3,514,000 last year.

New construction undertaken up to Nov. 15 included 243 miles of grading, 166 miles of stabilized base surfacing, 150 miles of gravel surfacing, 303 miles of bituminous surfacing, and 32 miles of shoulder surfacing. The bridge division is completing a total of 17 bridges and grade crossing separations contracted prior to the beginning of this year. Before the end of 1939 it will have placed under contract 31 new structures of which 20 are scheduled for completion this year.

• • •

Injunction Would Halt Birmingham, Ala. Housing

The W. S. Dickey Clay Manufacturing Co. has filed an injunction petition in the Birmingham, Ala., Chancery Court seeking to halt construction on the Elyton housing project in Birmingham. The housing authority, it is claimed, permitted substitution of concrete pipe for vitrified clay pipe in the sewage system for the project without allowing all the bidders to take the change into account. Named as defendants are: the housing authority, the Standard Building Material Co., Birmingham, and the J. A. Jones Construction Co., Charlotte, N. C.



Des Moines Register & Tribune Photo

IOWA HIGHWAY BRIDGE COLLAPSES

RECENTLY an 80-ft. pony truss north of Webster City, Iowa, collapsed, five persons narrowly escaping injury. M. Y. Kinne, engineer of Hamilton County, and E. W. Blumenstein, bridge engineer with the Iowa State Highway Commission, said they believed that one of the two cars on the bridge at the time of the accident hit the corner of the span causing the failure.

Joint Group Revived To Study Contracts

Engineers and contractors to study needed changes in contract procedure

Meeting last week for the first time in six or eight years, the Joint Conference on Standardized Construction Contracts was sufficiently impressed by a plea for changes in contract procedure presented by the Associated General Contractors that it set up a permanent organization and arranged to meet again in February. The joint conference is a long-dormant group representing numerous construction organizations, including Am.Soc.C.E., A.W.W.A., A.R.E.A., A.E.C., A.A.S.H.O., W.S.E., and A.I.A. It convened last week at the request of A.G.C.

Emergency clause

Most important recommendation submitted by A.G.C. was that all construction contracts, public and private, include an emergency clause modeled after the Army's contract form for use in wartime. Such a clause would provide that if an emergency were proclaimed by the President, the contractor would be reimbursed for any delays or increased costs occasioned by the emergency. A procedure for termination of contracts on the basis of cost plus an agreed percentage would also be provided.

Other contract innovations urged by A.G.C. were universal application of the Engineer Corps' clause providing that the owner absorb taxes imposed after letting of the contract, and provision, in government contracts, for payment to the contractor for delays caused by the government.

Mistakes in specifications

A.G.C. also complained of various provisions now common in contracts. One of these is the practice of specifying a method or type of construction and requiring that the contractor guarantee obtaining a specified result. Others are refusal of owners to guarantee elevations or borings shown on the plans and inclusion of "catch-all" clauses requiring the contractor to assume responsibility for mistakes in specifications.

Committee appointed

John W. Cowper of Buffalo, an A.G.C. representative, was elected chairman of the permanent organization; Thomas U. Urdahl of the American Engineering Council was made secretary; and H. E. Foreman, assistant managing director of A.G.C., was elected executive secretary.

Apprenticeship Pool Proposed in New York

An apprenticeship system in which the apprentices would be maintained in a pool, and bound to the trades rather than to individual employers, has been proposed by a joint committee of the New York Building Trades Employers Association, the New York Building Congress and the Building and Construction Trades Council of New York. Details of the plan are summarized in the current issue of *News and Opinion*, published by the B.T.E.A. Once the number of apprentices in each trade is decided upon, the boys would be kept in a pool and be taken on or released in approved numbers according to work available. The number of apprentices given to each employer would be in some ratio to the number of mechanics on his jobs.

While a central commission would have charge of the apprenticeship system generally, the plan provides that each trade, or several trades together, shall set up apprenticeship supervisors or committees in their trades to establish and maintain the system, and to determine the number of apprentices, qualifications, enrollment and placing. The proposal does not specify a specific list of trades to come under the plan. It is believed best not to try to include the whole industry at present, as several trades and a few employer groups already have apprenticeship systems. The plan has not yet been approved by all concerned, nor have the necessary appropriations been made to carry it out.

• • •

Height of Ross Dam To Be Increased

Ross Dam on the Skagit River in Washington will be built to El. 1,380 instead of El. 1,350 at an additional cost of $230,000, according to the Seattle board of public works. General Shea-Columbia, the contractor, has been granted a 91-day extension of time for completion of the project; the completion date now being set for March 31, 1940.

• • •

Willard Conlon Resigns As N.S.P.E. Secretary

Willard S. Conlon, Washington, D. C., has resigned as executive secretary of the National Society of Professional Engineers, effective Jan. 31. Conlon became treasurer of N.S.P.E. upon its foundation in 1934 and executive secretary a year later; previous to being made secretary he was city engineer of Stamford, Conn. Before that he worked for Jackson & Moreland, Boston, and for Bacon & Davis, New York.

BRIEF NEWS

TRACES OF SEWAGE POLLUTION were found in more than 70 per cent of 18,000 samples of water taken from rural water supplies in Jefferson County, Ky., according to a preliminary report by M. L. Miller, county sanitary engineer. "In some areas sewage was detected in 100 per cent of the samples," Miller stated in telling of the WPA survey.

THE ATTORNEY GENERAL of Connecticut has been ordered by Governor Baldwin to take legal action to recover excess profits paid out to real estate men for the right-of-way in Fairfield County for the Merritt Parkway. Testimony will be sought to show that prices paid for right-of-way land were increased as a result of a split-commission agreement. This will put the state in a position of obtaining damages in all cases where it can be proven that a fraud was part of the transaction.

AT THE CLOSE of the 1939 fiscal year only 45.4 per cent of the nation had been mapped topographically, according to the annual report of W. C. Mendenhall, director of the Geological Survey. During the year 28,000 square miles in 45 states, Alaska and Puerto Rico were surveyed for topographic maps, it was stated.

• • •

$6,100,000 Road Bonds Approved in Mexico

Advancement of Mexico's highway system is assured with congressional approval of a measure calling for an issue of $6,100,000 of federal bonds. The measure stipulates that most of the money be spent in advancing the southern section of Mexico's contribution to the Pan American Highway, or that between Mexico City and the Guatemalan border.

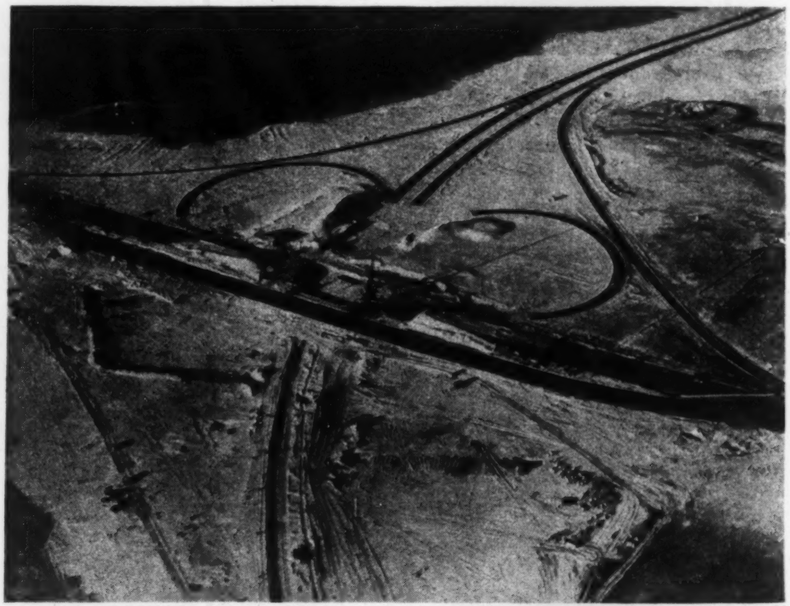


Photo by Rudy Arnold

CLOVER-LEAF FOR NEW YORK BELT PARKWAY

ONE of 70 projects to eliminate all grade crossings on the non-stop 31 mi. Belt Parkway nearing completion in New York City is the cloverleaf shown above, which is under construction at the intersection of the parkway and Flatbush Ave. in Brooklyn. When completed, the parkway will provide for four lanes of traffic, two in each direction separated by a 32-ft. medial strip. Other safety features besides separation of traffic are: lighting at night, a color contrast for main route and exit and entering lanes, white cement curbs, pedestrian underpasses, and banking on curves of less than 8,000 ft. radius.

The project is being carried out by the New York City park department in cooperation with the state department of public works. Madigan-Hyland, New York, is the engineering consultant. Cost of construction for the entire project is $28,000,000.

For the clover-leaf shown, the Elmhurst Contracting Co., Inc., New York, represented on the job by Chas. Malis, is the general contractor. This work is costing $460,000.

High Point Hearing Postponed Until March 5

The North Carolina Supreme Court on Dec. 14 postponed until its spring term, or March 5, hearing of all oral arguments in an appeal from the order that halted work on the $6,500,000 hydro-electric project being built by the City of High Point on the Yadkin River.

Hearing of the appeal was to have begun Dec. 15, but postponement was asked by the counsel for the city, continuance having been granted on the grounds that the city needed more time in which to study opposition briefs.

The right of the city to build a project under a federal license and navigability of the river are among the points in issue.

• • •

A.G.C. Asks Los Angeles To Cancel Large WPA Job

The Associated General Contractors of America have asked the city council of Los Angeles, Calif., to cancel the construction of the Aliso Street Viaduct as a WPA project. This heavy construction project calls for the expenditure of two and a half million dollars and involves two steam railroads, the entire eastern division of the Pacific Electric, a highway crossing of the Los Angeles River, a grade separation and construction of a temporary detour bridge across the river.

The A.G.C. has also asked that the project be investigated, pointing out that the work was set up as a PWA project to cost $2,025,000 but when revised for WPA work, the cost was increased to $2,425,000, or 20 per cent.

It is further pointed out that no WPA funds can be promised beyond June 30, 1940, and that it would be physically impossible to complete the work by that date.

• • •

London Continues Work on Waterloo Bridge

In spite of the present war situation, work is being pushed on the new Waterloo Bridge over the Thames River in London, the project being the biggest engineering undertaking in that city at the present time. According to present plans, the bridge will be opened to traffic next June, but the temporary structure now in use will remain in service for the duration of the war. Plans for a $10,000,000 approach improvement will be dropped for the present.

The bridge will consist of five 250-ft. reinforced concrete arches.

Damages Awarded For Forced Idleness

Contractor gets rental for his equipment tied up by government order to stop work

The Federal Court of Claims in Washington, D. C., recently awarded Joplin & Eldon, Portland, Oregon, contracting firm, $38.000 as damages against the federal government. The ruling ends five years of litigation over equipment tied up on a highway project in Mount Ranier National Park in the State of Washington.

Joplin & Eldon contracted in July, 1926, to build a 9-mile highway at Mount Ranier Park, the work to be finished by July 1, 1928. Subsequently, due to the authorization of additional work the date of completion was extended to Jan. 1, 1929. Early in October, 1928, with completion by Jan. 1 in sight, the contractor was advised that as the Park Service had a limited supply of cash, and as additional cash was not available until Congress acted, the contractors should shut down or finance themselves. On Oct. 15 the contractor decided to stop work and the order to again proceed was not received until June 21, 1929, work being resumed at that time and the project completed by Nov. 20 of that year.

Machinery idle

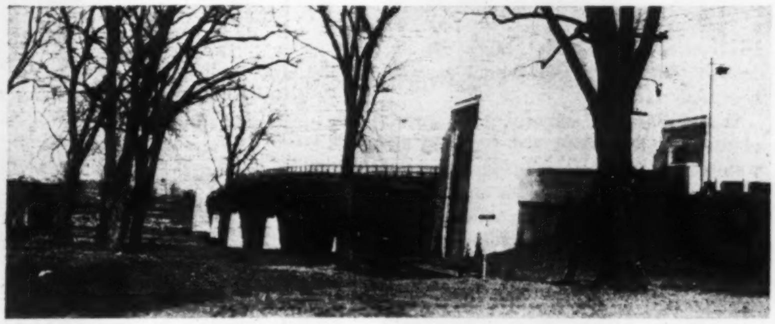
Damages charged by the contractors for moving equipment, and loss of rental for forced idleness of the machinery amounted to $38,280. The question then arose as to whether the notice by the defendant to suspend work because of lack of funds constituted a breach of contract.

Last June the Federal Court of Claims held that the contractors were entitled to damages, but the government attorneys moved for a new trial contending that action had not been brought by the contractors in the time limited by law, also that the contractors' equipment was not tied up and that there was nothing to prevent moving the machinery to another location during the time the machinery was idle. The final decision favored the contractor, who contended that it was too expensive to move the equipment under prevailing conditions.

• • •

Baltimore to Spend $2,500,000 on Sewer Work

The City Plan Commission of Baltimore has approved a $2,500,000 sewer loan for the improvement of sanitary services, mostly sewers in the eastern and southern sections of the city.



COOLIDGE SPAN DEDICATED

NEW ENGLAND's latest "flood" bridge (above), the Calvin Coolidge Memorial span over the Connecticut River between Northampton and Hadley, Mass., was dedicated recently. Costing $1,314,800, it has been open to traffic since last January. At the right is a photograph, taken during the March, 1936 flood, of the old bridges upstream, which the new bridge replaces. They have barely escaped many washouts.

The new bridge consists of two simple end spans 203 ft. long and 3 continuous central spans, 260, 296 and 260 ft. long, respectively. The trusses carry a 40 ft. roadway and an 8 ft. sidewalk. The W. & L. Engineering Co. and Maurice A. Reid were consulting engineers, and Desmond and Lord were consulting architects. T. Stewart & Son Co. was general contractor. It is a project of the State Department of Public Works.

OBITUARY

Ned King, 87, pioneer waterworks engineer, died in Durham, N. C., Dec. 9. King has been connected with the Durham waterworks as an engineer ever since its organization.

John L. Richard, 73, engineer of the Lenawee County, Mich., road commission since its organization in 1919, died in Adrian, Dec. 8. Prior to becoming engineer for the road commission, Richard was city engineer of Adrian for nine years.

Maxime Reber, 73, former consulting engineer of the St. Louis City Plan Commission, died Dec. 11 in St. Louis. Reber graduated from Washington University in 1888 with a civil engineer degree. He served for a time as president of the Board of Public Improvement in St. Louis.

Louis H. Hoffmann, 51, for the past 20 years president of the Hoffmann Bros. Construction Co., St. Louis, died in that city Dec. 7.

John C. B. Koonce, 43, division engineer at Sanford, for the North Carolina state highway department, died Dec. 10. Koonce had served as engineer for the state highway and public works commission for the past 20 years. He was a graduate of the North Carolina State College.

Charles I. Hickman, superintendent of the traffic engineering survey for the Chicago Park District, died Oct. 16. Hickman was a graduate of Purdue University.

Manuel A. Brazos, 73, president of A. Brazos & Sons, Middletown, Conn., road builders, died Dec. 12. Brazos succeeded his father 25 years ago as head of the Brazos company.

Anthony F. Grunenthal, 65, assistant engineer in the bureau of sewers in the Borough of Queens at New York City, died Dec. 11 in New York City. Grunenthal had been in the city service for about 40 years.

George R. Newell, for 30 years a practicing engineer at Rochester, N. Y., died in that city Dec. 13. Newell graduated from Harvard University in 1904. The engineering firm of George R. Newell, Inc., was organized in 1924.

William F. Miller, 55, assistant to the chief engineer for maintenance of way, eastern region of the Pennsylvania R. R., died in Ardmore, Pa., Dec. 18. Miller joined the railroad in 1903 as a member of the engineering corps for the Philadelphia terminals division.

S. A. Desmeules, engaged in various engineering activities in Canada during the past 35 years, died recently in Father Point, Que. Desmeules had worked with the National Transcontinental Ry., the Quebec and Saguenay Ry., the Lake St. John Paper Co., and the Ontario Paper Co.

Other recent deaths include: George W. Christian, 89, former surveyor of St. Francis County, Ark., Forrest City, Ark.; Charles S. Chisholm, 72, building contractor, Bellingham, Wash.; Frank Marshall, 74, retired building contractor, Seattle, Wash.; Dominick Gregory, 86, building contractor who retired seven years ago, Olean, N. Y.; John C. Werner, 70, retired builder, Tucson, Ariz.; Thomas S. Griffiths, 72, builder, Montreal, Que.; Byrd A. Nebeher, 80, builder, Santa Monica, Calif.; William W. Winter, civil engineer of the Allis-Chalmers Co., Kenosha, Wis.; Frank Huddleston, structural engineer, Chicago, Ill.

CONTRACTS AND CAPITAL

Engineering construction awards for the week total $47,702,000, an increase of 19 per cent over a week ago, but 45 per cent below the volume for the corresponding week last year.

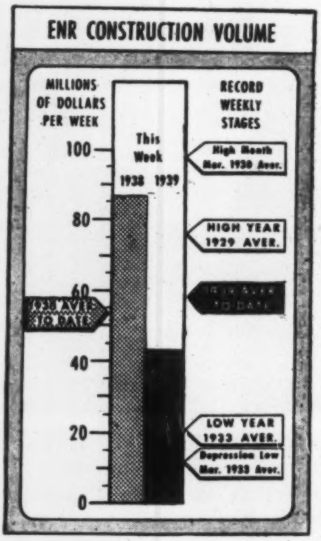
This week's construction total brings 1939 volume to $2,958,128,000, a gain of 8 per cent over the $2,732,421,000 reported in the 51-week period a year ago.

Public construction for the week tops last week by 71 per cent, but is 46 per cent lower than in the week last year. Private awards drop 50 per cent under a week ago and 39 per cent under a year ago. This is the first time in 15 consecutive weeks that private awards have fallen below their respective 1938 values.

In the classified construction groups, gains over last week are reported in waterworks, sewerage, bridges, earthwork and drainage, streets and roads, and unclassified construction; increases over the 1938 week are in industrial buildings and streets and roads.

New capital for construction purposes for the week, $6,871,000, is 86 per cent below the volume reported for the corresponding 1938 week. The current week's new financing is made up of $6,221,000 in state and municipal bonds, $600,000 in corporate security issues, and $50,000 in RFC loans for public improvements.

New construction financing for the year to date totals $2,394,882,000, a decrease of 35 per cent from the $3,679,637,000 volume for the 51-week period last year.



CONTRACTS

(Thousands of dollars)

	Week Ending Dec. 22 1938	Dec. 14 1939	Dec. 21 1939
Federal	$10,614	$3,689	$8,867
State & Municipal	61,625	19,101	30,089
Total public...	$72,239	$22,790	$38,956
Total private..	14,358	17,368	8,746
TOTALS	$86,597	$40,158	$47,702

Cumulative
1939 .....(51 weeks)....$2,958,128
1938 .....(51 weeks)....$2,732,421

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial building, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1938 51 Wk.	1939 51 Wk.
NON-FEDERAL ...	$2,535,942	$1,266,854
Corp. securities ..	375,784	213,803
State & Mun.....	736,457	559,640
R.E.A. loans.....	76,106	89,445
R.F.C. loans.....	101,844	—1,845†
P.W.A. allot.....	723,265	......
U.S.H.A. loans...	320,986	215,811
Fed. Aid—Hwys..	201,500	190,000
FEDERAL	$1,143,695	$1,128,028
TOTAL CAPITAL..	$3,679,637	$2,394,882

† $10,000,000 RFC loan transferred to state and municipal bonds.

FHA MORTGAGES

	Week Ending Dec. 17 1938	Dec. 9 1939	Dec. 16 1939
Selected for appraisal ...	$19,452	$19,324	$17,900*

Cumulative
1939 ....(50 weeks)....$1,096,941*
1938 ....(51 weeks)....$ 987,604

* Subject to revision.

ENR INDEX NUMBERS

Index Base = 100		1913	1926
Construction Cost	Dec., '39	238.17	114.49
Building Cost	Dec., '39	201.21	108.77
Volume	Nov., '39	219	96

Drought General Over Nation

Last three months driest on record for country as a whole, excluding three southwestern states

The three months of September, October, and November were the driest on record for the United States as a whole, if three southwestern states are excluded. No improvement, moreover, has yet occurred; during the first two weeks of December there were none but local rains east of the Rockies. As may be seen by the map below, very dry conditions are universal throughout the Great Plains and extend in a broad north-south belt through the Southeast.

Rainfall for the three months was less than half of normal in ten states, as shown in the following table:

PRECIPITATION, NORMAL AND ACTUAL, FOR SEPT.-NOV.

State	Normal	Actual
Georgia	9.04	4.01
Illinois	9.13	4.22
Iowa	7.81	2.82
Kansas	6.09	1.75
Nebraska	4.53	1.16
N. Dakota	3.26	1.46
Oklahoma	8.12	3.36
Oregon	6.87	3.18
S. Carolina	9.45	4.07
Tennessee	9.51	4.19

Because the Fall is normally a period of comparatively low rainfall, the effect on ground-water and streamflow is not as great as might be expected from the percentage figures on precipitation. The Geological Survey, which usually gathers weekly figures on these points during severe droughts, has not yet begun to do so. It is known in a general way, however, that although streamflows are low they are nowhere reaching record lows.

Although streamflow figures are collected only by the Survey, the Weather Bureau does collect daily information on stages. It will be seen in the table below that stages are still 3 to 8 ft. above lows of record. Stage readings, of course, are of somewhat dubious value as far as low flows are concerned because all the major watersheds in the area concerned—Missouri, Mississippi, Ohio, Tennessee—are more or less controlled, and the stages reflect what are almost pool levels. The stages late last week at five critical stations are given below, as well as the low of record and the low year.

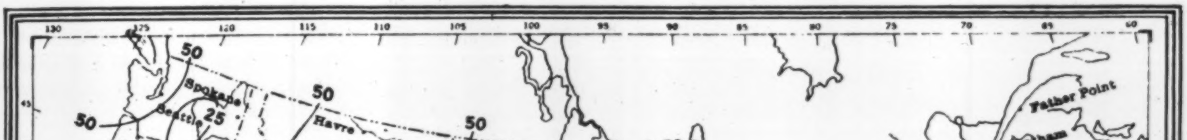
Location of station	Stage last week	Record low	Year recorded
Bismarck	4.3	0.9	1913
LaCrosse	4.7	−2.5	1936
St. Louis	−1.3	−5.5	1937
Cairo	7.5	−1.0	1871
Little Rock	−1.4	−4.2	1934

The moderate replenishment of groundwater which normally occurs at this season is in some cases failing to show up. In Iowa and the Dakotas a number of shallow wells—usually on the danger line in the Fall—are known to have failed, and some farmers are hauling stock water. Deep aquafers, however, are not yet seriously affected, and no failures of domestic or municipal water supply have been reported. A more serious condition might result if the lack of rain continued long enough to prevent normal winter replenishment.

· · ·

$2,500,000 Dam Proposed For East Texas

Four cities of East Texas, Tyler, Jacksonville, Palestine and Athens—have proposed to solve their water supply problem by building a $2,500,000 dam on the Neches River in Anderson County. Backers of the project say that the dam will not only assure an adequate water supply to the four cities, but would also aid in the soil conservation program and in flood control. Because of this latter benefit it is hoped that a federal loan may be obtained for financing the work.



50
25
100
150
200
300
500
Spokane
Seattle
Portland
Roseburg
Boise
Red Bluff
Winnemucca
Reno
Tonopah
San Francisco
Los Angeles
Salt Lake City
Modena
Havre
Helena
Williston
Bismarck
Moorhead
Lander
Cheyenne
Denver
Durango
Santa Fe
El Paso
Huron
Rapid City
St. Paul
Sioux City
Des Moines
Lincoln
Topeka
Dodge
Springfield
Amarillo
Oklahoma City
Little Rock
Abilene
Shreveport
San Antonio
Galveston
New Orleans
Vicksburg
Montgomery
Memphis
Nashville
Chattanooga
Atlanta
Augusta
Charleston
Savannah
Jacksonville
Tampa
Key West
Milwaukee
Chicago
Peoria
Indianapolis
St. Louis
Cairo
Louisville
Cincinnati
Columbus
Marquette
Sault Ste. Marie
Alpena
Grand Rapids
Port Huron
Cleveland
Buffalo
New York
Philadelphia
Washington
Richmond
Raleigh
Atlantic City
Oswego
Northfield
Boston
Montreal
Quebec
Chatham
Father Point
Eastport
Halifax

PERCENTAGE OF NORMAL PRECIPITATION FOR THE SEPTEMBER-NOVEMBER PERIOD

SHADED portions indicate normal precipitation or above, unshaded areas below normal. The lines show percentage of normal for the three months of September, October and November of the current year.

COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

Bridges at Laredo

Sir: On page 36 of the Aug. 31, 1939, issue there is a news item entitled "Texas Turns Down Plans for Free Bridge at Laredo" in which it is stated "although Mexican government engineers have long claimed that the present toll bridge was inadequate, it has been given a clean bill of health recently by traffic engineers employed by the Texas Highway Department."

The title and this statement may be misleading, because the Texas State Highway Department has not employed traffic engineers to make a traffic count over the present toll bridge, nor does it agree with the conclusion that the present bridge is adequate for future traffic.

JULIAN MONTGOMERY
State Highway Engineer
Texas Highway Department

The report referred to, on a "Regional Highway Plan for the Laredo Metropolitan Area and Webb County, Texas," was made by W. O. Washington, Brownsville, Tex., and H. R. F. Helland, San Antonio, Tex. The work was financed through a cooperative arrangement of the state highway department, Webb County, and the city of Laredo. The news item in question stated only the opinion of these engineers which, as Mr. Montgomery points out, should not be taken to imply that this is the opinion of the state highway department.—EDITOR.

Foundation Wells

Sir: In your issue of Oct. 12, page 46, editorial approval is implied of a method of pier installation proposed by a contractor to be installed in Chicago as described in an article on page 61 of that issue. You remark "it remains for the promoters of this new method to convince the building code authorities that the complete method is safe" and "on the code authorities rests responsibility for not carrying caution to the extreme of limiting progress in the use of new methods of construction."

The article on page 61 describes in substance the Powell method for sinking cylindrical caissons to rock, this method having been introduced some ten years or more ago and being fairly well known; several foundation installations of this type having been made in Chicago and Detroit as well as New York and vicinity. In the usual procedure with this method a suspended mud or slurry is maintained in the hole as the rotating bit or cutting tool bores its way to the rock bottom, slurry being injected around the bit and the finer particles of soil overflowing with the water at the top of the hole. When the bit reaches the bottom it is withdrawn and a steel shell is lowered through the slurry to the bottom. The hole is then cleaned out, the bearing surface prepared, and the hole filled with concrete in the dry. Where boulders and coarse materials exist, as mentioned in the article, they usually settle to the bottom of the hole and are mucked out in the cleaning up process.

At the Chicago job, described in the article, a modification of the Powell method is apparently requested by the contractor, who proposes to concrete the piers by tremie method, and, I infer, *without first cleaning out the materials in the hole* and *without preparing the bearing surface of the rock as is usually done,* the concrete being injected through tremie pipes to the bottom of the hole "pushing up the water-clay slurry."

Where piers of this type are constructed to bear on bedrock, the bearing intensities are usually fairly high and good engineering practice dictates that the bearing surfaces be sound and properly prepared, also that the concrete filling of the piers be of unquestioned quality and strength. In my opinion the impossibility of properly preparing and inspecting the bearing surfaces involved in the proposed modification of the Powell method and the reliance on concrete injected through mud and perhaps boulders to form the body of a highly stressed pier, is not good engineering and should not be approved by authorities having jurisdiction over such foundation work.

Tremie methods of placing concrete are only used when other methods are uneconomical and infeasible, concrete placed in the dry being preferred, especially in highly stressed pier shafts. Where concrete is to be placed by tremie, the excavation should be completed before placing the concrete and the concrete itself should not be used as a medium by which the earth is pushed aside or removed, with the consequent danger of its becoming trapped or entrained within the body of the concrete.

In view of the blind faith which many readers place in whatever they read in the papers and particularly in the *Engineering News-Record,* it seems unfortunate that you have indicated both approval of the contractor's proposed modification of the Powell method and criticism of the code authorities for being cautious in the matter of approving it.

GEORGE L. FREEMAN
Moran, Proctor, Freeman & Mueser
New York, N. Y.

No blanket endorsement of the method described was intended nor was the building code authority condemned for not accepting the method; rather the purpose of our editorial comment was to point out that an obligation rests on the promoter to demonstrate that his method is safe and that likewise an obligation rests on the building code authorities not to shut out the method arbitrarily because it may be a radical departure from traditional practice if the promoters can satisfy competent authorities as to its safety.—EDITORS.

Welded Cable Saddles

In our "Contents in Brief" item preceding the article on welded cable saddles for the Tacoma Narrows Bridge by Jonathan Jones of the Bethlehem Steel Co. in our issue of Dec. 7, 1939, p. 773, it is incorrectly stated that these are "the first welded cable saddles on record". In his original manuscript Mr. Jones had stated only that these were the "first in the United States" but this statement was inadvertently omitted in the article.

While the Tacoma saddles are probably the largest which have been built of welded structural plates, welded saddles have previously been used on Isle of Orleans Bridge in

Quebec, completed in 1935, the Lions Gate Bridge, Vancouver, B. C., completed in 1938, and the Wabash River Bridge, Hutsonville, Ill., but recently completed. The Canadian bridges were designed by Monsarrat & Pratley, consulting engineers, Montreal, and built by the Dominion Bridge Co., Lachine, Quebec. The Hutsonville bridge was designed by Robinson & Steinman, New York, and built by the Wisconsin Bridge & Iron Co., Milwaukee.

Vehicle Tunnel Lighting

Sir: An article on "Lighting the Modern Road Tunnel," by R. W. Swetland in your issue of Aug. 31, p. 49, has been brought to my attention. Permit my comments thereon.

The determination of the proper illumination for vehicle tunnels involves two main problems, the lighting of the main body of the tunnel and the lighting of the entrance. For lighting of the main body of the tunnel, the detail that the article stresses is the value of foot-candles on the roadway surface. Thus the author speaks of 0.5 to 1 foot-candles in some of the older tunnels, 2.5 foot-candles in the Liberty Tunnel and 5 to 7 foot-candles in the projected Montreal Tunnel. This gives the implication that the higher the foot-candles on the roadway surface the better the vision. This provokes a question. Why should the foot-candles on the roadway surface be the criterion for seeing other cars any more than foot-candles on the floor of a room should be the measure of the ability to see other persons or the furniture? You see the other persons by the light that falls on them or by the contrast between the light that is reflected from them as compared with the light reflected from the walls just beyond. This light comes from luminaires and not from the floor.

I admit that this argument is theoretical. However, arguments from actual practice are not hard to find. Of all the tunnels I have seen none can compare in effectiveness with the Holland Tunnel, the Lincoln Tunnel and the East Boston Tunnel. By the word "effectiveness" I mean ability to see the other cars and attractiveness to the public. In the Holland Tunnel the intensity of light on the roadway surface is about 1.5 foot-candles. In the Lincoln Tunnel it is slightly less, but paradoxically the lighting is better both as to ability to see the other cars and in attractiveness. Compared with this is one of the western tunnels. I have read that the illumination of the roadway in that tunnel is between 20 and 25 foot-candles. From personal inspection I can testify that the vision in this tunnel is very poor.

On highways the roadway surface is the background against which vehicles are silhouetted and the foot-candle intensity on this surface is a matter of great importance. The fact that most manufacturers' representatives who advise on tunnel lighting stress the importance of the foot-candle intensity on the roadway suggests that they have been recruited from the ranks of those who have been trained in the requirements of highway lighting. If so, their training for tunnel lighting is wrong. The problems of providing sufficient light for the body of the tunnel are clearly those of interior lighting. The problems of entrance portal lighting are in a class by themselves and are not met either in highway lighting or in interior lighting.

At the entrance portals, special means are wanted to permit safe transition from the bright sunlight to the low level of the tunnel lighting. For this part of the tunnel the article under discussion suggests three tried solutions. Method No. 1: Construction of an overhead louvred ceiling some 200 ft. out from each portal. Personally I have found this unsatisfactory, possibly for the reason given hereinafter. Method No. 2: Build the tunnel entrances on a curve or with a very large entrance. Personally I have found this very satisfactory, but I believe that the good results were due to local conditions. As the article points out, this method is often impracticable. Method No. 3: Provide an adequate level of graduated artificial illumination along 200 to 300 ft. of the tunnel entrance.

To show the public that in Mobile we are doing our best with entrance lighting, we are providing illumination of this nature in the Mobile Vehicular Tunnel, but it is being provided mainly as a gesture to the public. So far, I have seen no satisfactory vision for portals obtained by artificial lighting. Sunlight has an intensity of, say, 8,000 foot-candles. Whether the lighting in the tunnel is 1 foot-candle, or 5, or 50, or 500, the transition is extreme, and it is necessary only to state the problem to realize the difficulties. I have experienced difficulties in vision in two respects at tunnel entrances. At the New Jersey entrance to the Holland Tunnel my most intense lack of vision is when standing in the sunshine just out of the tunnel. At this point it is very difficult to see even 50 ft. within the tunnel. This difficulty entirely disappears as soon as I have entered the shadow of the portal. There is no transition stage. One passes from a position of very low vision to one of extended vision in almost zero time. To provide a bright background against which vehicles could be silhouetted we temporarily illuminated a section of the roadway to 300 foot-candles, but without success.

In the Broadway-Oakland Tunnel to which the article refers, after driving for a long distance in the glaring sunlight my vision in the tunnel was extremely bad, and it was not until I had practically reached the exit that my vision had recovered. Others who have arrived at the New Jersey entrances of the New York tunnels after a long drive over the New Jersey highways have had the same experience that I had in the West.

Ability to see in reduced light is due, I am told, to the presence in the eye of a chemical called the visual purple. This is bleached out after long exposure to bright light. When bleached out it requires a long time for the body to restore it. Ability to see after entering dark room comes not after the few seconds necessary for the pupil to open but after minutes. Anyone may notice this by going into a moving picture theatre during a performance. After a number of minutes in the theatre it is possible to see the seats and other interior details. Possibly this chemical is not badly bleached out when driving through the alternate light and shadow of city streets, and entering a tunnel from a city is different from entering from the open roads.

The article states that providing entrance lighting in the neighborhood of 100 foot-candles is an effective tried solution. May I request that the author advise us of some actual installations so that other engineers may study them and decide for themselves of the extent to which difficulties have been overcome?

J. N. Dodd
Consulting Electrical Engineer
Wilberding & Palmer
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CHRISTMAS, from its very beginning, has been a time for looking forward, for renewing confidence in the future, and for girding ourselves for a new try to make this a better world in which to live. Despite war's thundering abroad and a seemingly growing number of unsolved problems at home, the wisdom of such a spirit of optimism and good intention has not been successfully challenged. Although not given to sentimental reflections over their jobs, engineers and construction men can well take pride in following a calling in which this spirit of Christmas is a fundamental principle. It is perhaps not too much to hope that in their daily tasks of making this a better world in which to live, engineers and construction men can also contribute something to that greatest of ideals, Peace on Earth, Good Will Toward Men. In this spirit and with this hope, *Engineering News-Record* wishes all of its readers a very Merry Christmas.

Looking Ahead

A NEW YEAR is just around the corner, following hard upon a period of substantial technical accomplishment and reasonably active construction. In looking ahead, confusing trends, engendered by war abroad and a national election on the domestic front, make prediction difficult. Yet, facts and trends are in evidence that may serve as an aid to planning. A construction volume of nearly seven billion dollars in 1939 will represent an 8 per cent advance over last year, partly made possible by large federal spending but aided materially by increased private construction, which goes into the new year on a rising trend. As federal purse strings are pulled tighter, public construction can hardly hold at present levels unless states and cities reassume their financing responsibilities. Many of them have already done so, but a year is a short time to throw off completely the psychology of leaning on Uncle Sam. Housing, utilities, commercial and industrial buildings offer the greatest possibilities for growth, while highway construction will at least hold to its existing high level. Weighing all factors as realistically as possible, 1940 construction should about equal that of 1939. In view of world conditions the possibility of such a high construction tempo is cause for satisfaction.

New Road Design Principle

THE DEVELOPMENT of the modern highway from the wagon road of a generation ago has been primarily a growth in width. New grade and line improvement over old practices shows far less change than does cross-profile. This progress of development in width, ending in the divided highway, is outlined in this issue in the first of a series of articles on present practice in the structural design of segregated traffic roads. The point to be noted, however, is that the divided highway involves a new highway design principle which transcends in importance any structural problems that physical division introduces. This is the principle of easement of traffic friction by segregation. Roadway widening alone, the practice until the middle of the present decade, constantly increased the frictional surfaces of moving vehicles. The divided highway is the first step toward decreasing the number of surfaces of dangerous contact, thereby increasing both traffic capacity and safety.

Traffic and Tolls

SUCH HUGE FIGURES as 100,000 vehicles per day for the full year's average, or 20,000 vehicles per lane per day, form the background of the Queens Midtown Tunnel enterprise in New York City, whose design and construction is described in this and a succeeding issue. Few facts better reflect the magnitude of the modern city traffic problem. Relief of the Queensboro Bridge, to which the quoted figures pertain, has long been the subject of dreams and debates, but hitherto without result. The most obvious relief, improvement of the inadequate terminals, never appealed to the city authorities, and construction of the rather distant Triborough Bridge produced more new traffic than it took from the older structure. The tunnel, competing directly with the Queensboro Bridge and offering a shorter and freer route to most points, is certain to take a substantial amount of the bridge traffic. In doing so it will furnish important data on public recognition of better facilities, since its 25c. toll will be compared with free-of-cost but inconvenient and slow passage over the bridge. For this reason as well as because it is an unusual example of efficient traffic planning and construction skill the tunnel well repays close study.

Job Organization

SUCCESS IN BUILDING CONSTRUCTION depends largely upon job organization and management. Not much can be done about materials, for their quantity is fixed and their price is about the same to all bidders. Labor rates are likewise fixed to all. In the application of labor, the judicious use of equipment and the technique of construction, however, the contractor can bring his experience and ingenuity to bear. An exceptionally well organized building project is that of the John W. Cowper Co. on the Commodore Perry housing development in Buffalo, described in this issue. Crews organized to perform definite operations move from unit to unit, always finding their required materials neatly stacked within easy reach. That all possible use is made of equipment is evident from the concreting operations; no hand labor is required for batching, mixing or distributing the concrete. Not only is the job operating efficiently but at a speed far in excess of contract requirements. The Commodore Perry project is a fine example of sound job organization.

Outfall Sewers

VALUABLE DATA on the design, construction and maintenance of subaqueous outfall sewers has been assembled in the series of articles by N. A. Bowers, which is concluded in this issue. The installation of an outfall sewer is a specialist job in the highly specialized science of sanitary engineering, and no such thing as a "standard design" exists. Therefore, this report of experience on many projects in different parts of the country should serve as an authoritative guide in making decisions on design and construction. Experience shows that cast iron, wrought iron and concrete are all adapted to the severe service requirements occasioned in carrying sewage through a corrosive medium such as seawater; steel pipe, which has the advantage of relatively lower cost, has also been used and has proved successful when electrolytic corrosion was eliminated. Summarizing outfall service records, it appears that joint failures are the number one problem, breaks caused by foundation settlement or failure are next in importance, and that sand and grease clogging ranks third in order of maintenance difficulties. Discussion bearing on the methods used in minimizing these troublesome features of outfall sewer operation forms, perhaps, the most valuable contribution of the series.

Bridges and Bombs

NEWSPAPERS IN NEW YORK, in opposing plans for a Battery-Brooklyn Bridge, used the recent attempt of the German air force to bomb the Firth of Forth Bridge in Scotland as an occasion to editorialize on the folly of placing a bridge seaward of a vital navy yard. They oversimplified a question upon which little is known from actual experience but whose fearsome possibilities have generally been discounted by engineers.

It is first proper to point out that, as a bomb did not hit the Firth of Forth Bridge, no new experience is available. But, if a bomb had caused the collapse of the bridge so that it blocked the ship channel, it would prove nothing so far as the Battery or any other suspension bridge is concerned. The Firth of Forth Bridge is of cantilever type. As compared with a suspension bridge, whose only vulnerable members are the two cables (the chance of a "pin-point hit" on the towers is too remote to be considered) the cantilever contains dozens of members that could initiate a collapse.

As between a wrecked cantilever and a wrecked suspension bridge, the cantilever would present by far the more serious obstruction. Its trusses are several times deeper. Its steelwork would probably not tear loose from the towers but would sag between them. Its members would fall in a twisted mass that could not be removed quickly. The suspension bridge, however, would completely separate from the towers and drop to the bottom. If not below shipping depths, it could be quickly pulled out of the way after a relatively few members were cut with a torch. Even though both towers were pulled inward by the collapse of the main span their tops would rarely reach the shipping channel.

Finally, until the bridge is brought down, none of these difficulties need be faced, and the chance of a bomb hitting one of two slender cables set 50 to 75 ft. apart would seem very remote. There may be valid reasons for opposing the Battery Bridge or any other bridge in a similar location but risk of bombing is not among them.

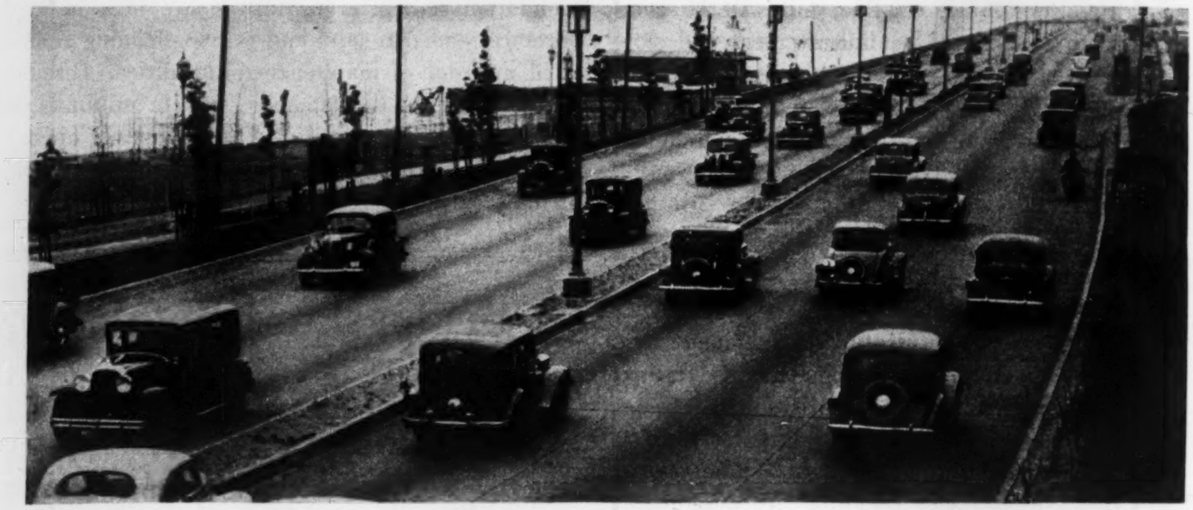


FIG. I. THE REASON WHY DIVIDED HIGHWAYS ARE NEEDED: HENRY HUDSON PARKWAY OUT OF NEW YORK.

Divided Highway Design—I

***Contents in Brief**—The development of divided roads came with the discovery that mere widening of pavements did not provide safer travel. Following discovery that separation was essential, trial designs were put into service. Design details that are crystalizing out of a study of these trial roads are discussed in this and two articles to follow. This article centers on cross-profile design and dimensions.*

INTRODUCTION

When roadbuilding turned actively a dozen or more years ago to four-lane and wider surfaces the thought was that the remedy for hazardous crowding and interference was to thin out the traffic by increased roadway width. Experience quickly indicated that mere widening was not sufficient. When traffic was given more room it traveled faster and the opposing currents of travel were tempted to trespass on each other's rights-of-way. Interference was not lessened; there were many reports that it had become more dangerous. Remedial half-measures such as special striping, reflector buttons and a variety of midroad obstacles served only to emphasize that complete physical separation was the only corrective.

Today the divided highway is the outstanding problem of road design. Essentially the problem is the four-lane divided highway since design principles for six-lane structure are the same and four lanes are normal practice. It is important to notice that the problem developed rapidly. Careful records kept by the Public Roads Administration show that until 1934 four-lane undivided highway projects were steadily increasing in number and four-lane divided highway projects had shown no increase, in fact a slight decrease, in number since 1932. In the two years following 1934 the rising curve of undivided four-lane projects flattened out and the declining curve of divided four-lane projects turned pronouncedly upward. These trends have continued and now advanced engineering opinion is agreed on the use where possible of a separating barrier between opposing currents of traffic on four-lane roads.

How is this new problem of the divided road being worked out? What design principles are being established? Are details becoming stabilized? To find an answer to these questions the search has been carried into the field. In a survey of current practice in some half-score of states active in four-lane road construction, the principle of division was found to be about the only one that was universally agreed upon. Practice varies in all details of cross-profile; lane and median-strip widths, use of curbs and methods of roadway drainage. As always in a new development, practice at the beginning is cautious in venturing beyond old boundaries. A period of experimentation ensues and divided highway design is in this transition stage.

At first glance all seems confusion but on looking closer a pattern is apparent. Taking a detail as an illustration: Current curb construction follows ten or a dozen designs but all adhere to the design principle that the curb must be safely surmountable by motor vehicles. Secondly, but less generally, the objective is that the curb must be clearly visible. It is these broader evidences of crystalizing practice that this article and two more to follow will emphasize. To go farther carries description into a multiplicity of individual design differences.

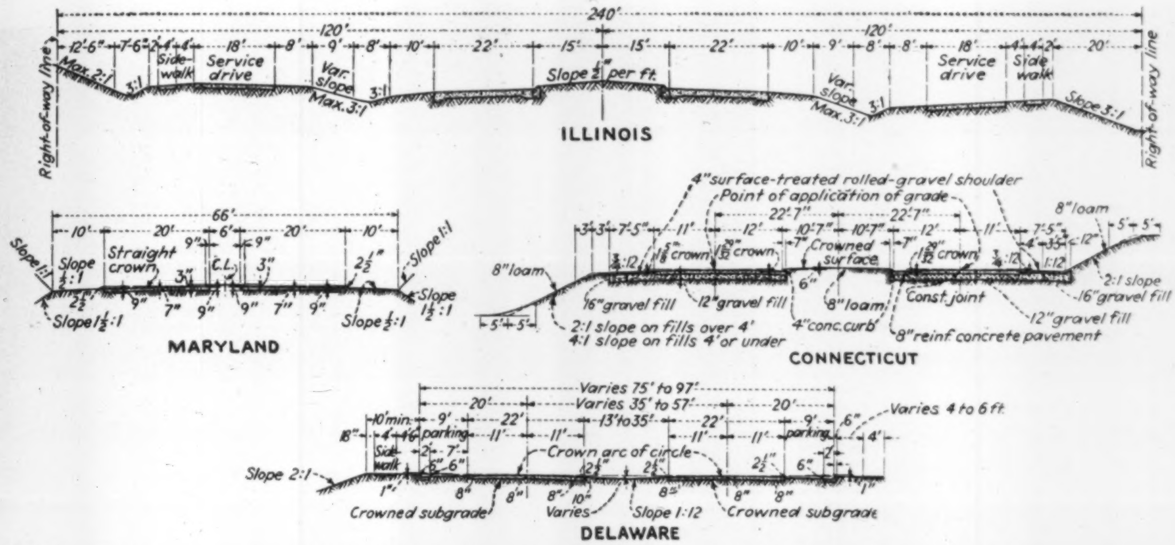

ILLINOIS
240'
120'
120'
Right-of-way line
Max. 2:1
3:1
Side-walk
Service drive
Var. slope
Max. 3:1
Slope 1/2" per ft.
Slope 3:1
MARYLAND
66'
Slope 1:1
Slope 1/2:1
Straight crown
C.L.
Slope 1 1/2:1
Slope 1/2:1
CONNECTICUT
4" surface-treated rolled-gravel shoulder
Point of application of grade
22'-7"
Crowned surface
8" loam
16" gravel fill
12" gravel fill
2:1 slope on fills over 4'
4:1 slope on fills 4' or under
4" conc. curb
Const. joint
8" reinf. concrete pavement
2:1 slope
DELAWARE
Varies 75' to 97'
Varies 35' to 57'
13' to 35'
Varies 4 to 6 ft.
10' min.
Side walk
parking
Crown arc of circle
Slope 2:1
Crowned subgrade
Varies
Slope 1:12

Fig. 2. Four recent four-lane divided highways show the range in cross-profile and dimensions. (1) Maximum development of the divided highway, with service roads and sidewalks, is represented by this road near Chicago. (2) A notable example of a design fitted to a narrow roadway is presented by the Governor Ritchie Highway from Baltimore to the Maryland state capital. (3) Use of a liberal roadway width is represented by the Hartford-Springfield road in Connecticut; probably as close an approach as may be to what is regarded as a normal section. (4) In Delaware, where the first long section of divided highway was built, this section indicates how commonly cross-profile must be adjusted to meet right-of-way limitations.

In the general terms indicated, discussion of divided highway design separates somewhat logically into: (1) cross-profile and dimensions, (2) median strip design and structure and (3) pavement and drainage.

CROSS-PROFILE AND DIMENSIONS

The divided road is an evolutionary growth and not the development of rational design. The growth of the modern highway has been a gradual widening from the center line outward. First, there was a widening of the traffic lanes and then of the shoulders from mere earth edgings to the ditch lines into true safety zones. With this development came the extension of cross-profile design to the roadside borders in the form of flattened and rounded ditch and backslopes and the streamline mergings of longitudinal cut-and-fill slopes. The addition of traffic lanes followed first a middle passing lane and then a doubling of the original two-line service. Separation of the opposing traffic lanes was the perfecting step now under consideration. With this came further emphasis of roadside border development for sidewalks and local-service roads or for landscaping.

These steps do not stand out clearly in the record, they merge and overlap and confuse each other but through all the march toward an ever-widening road is plain. But it is equally plain that the widening process has been predicated on compromise and not on rationalism. In any rational consideration of the road the graded roadway and the roadside borders are equal elements each performing a definite function. Widening should extend over both to be rational and this requires bolder planning than has always been dared.

With compromise always an influencing factor no standard of cross-profile and dimensions can be expected in practice and none is found. This is clearly indicated by the exam-

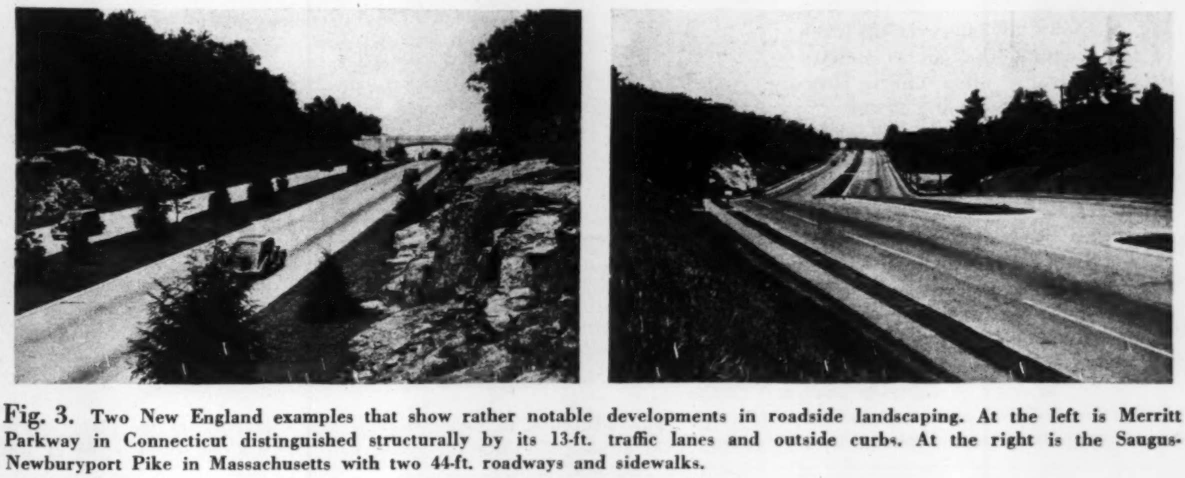


Fig. 3. Two New England examples that show rather notable developments in roadside landscaping. At the left is Merritt Parkway in Connecticut distinguished structurally by its 13-ft. traffic lanes and outside curbs. At the right is the Saugus-Newburyport Pike in Massachusetts with two 44-ft. roadways and sidewalks.

ples, all of recent roads, given in Fig. 2 and by the views Figs. 3 to 8. Considering cross-profile and dimensions in their full extension between right-of-way lines, the illustrations show the variety and irregularity of current practice. These conditions are less evident as the road elements are considered individually. But first the form of cross-profile, as shown by the illustrations, calls for notice.

Normally the cross-profile is horizontal; that is, all elevations of the graded roadway are the same on each side of the center line. This of course applies to transverse sections on tangents; on curves superelevation changes the cross-profile to various inclinations from the horizontal. In a measure practice appears rather to favor horizontal symmetry in cross-profile; in the illustrations only one, Fig. 5, shows advantage being taken of the economy that an asymmetrical cross-profile often offers. However, a change is coming about.

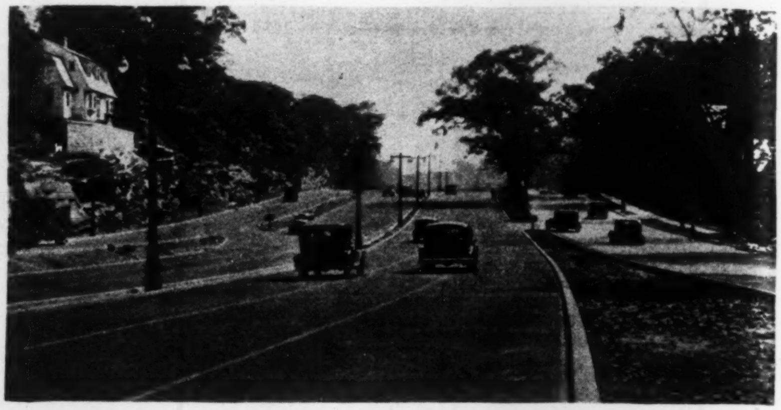


Fig. 4. Service roads on the Henry Hudson Parkway out of New York City segregate local and through traffic; the vertical curbs are now outmoded.

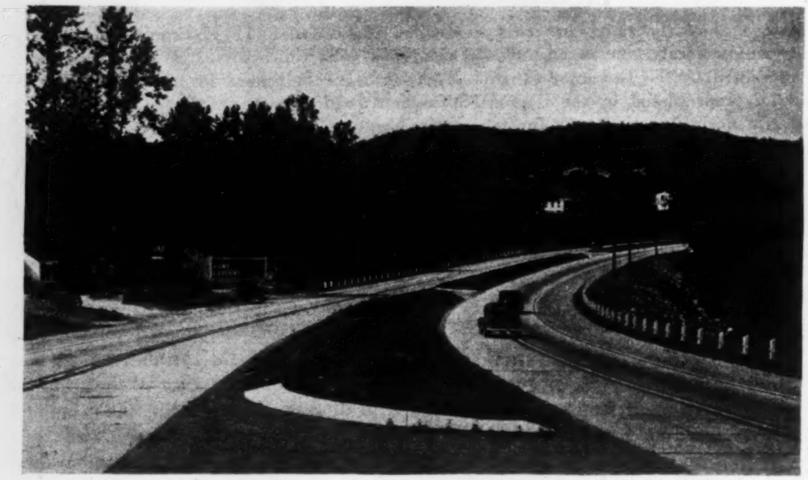


Fig. 5. On the Pompton Turnpike in northern New Jersey earthwork is reduced by locating the two roadways at different levels; note the inclined median strip and crossovers. This adjustment to rough topography is carried still farther on the Eastern State Parkway in New York where the roadways have been widely separated at some points to reduce grading and improve alignment.

Thoughtful designers are voicing the opinion that to crowd the topography by a slavish adherence to a symmetrical horizontal cross-profile of graded roadway is unwarranted. Some designs even urge that an asymmetrical arrangement of the two halves of the roadway be looked for in the lay of the land. For example, on a side hill or even a gentle slope as shown by Fig. 5 different pavement levels obviously reduce the excavation. It is also urged that driving is made easier particularly at night by reduction of headlight glare and the increased sense of independent roadways.

Superelevated cross-profiles have in practice clung somewhat closely to individual four-lane tradition—that is, superelevation is accomplished by rotating the cross-profile base line on the center line of the divided highway. This gives a straight slant from inside to outside of the curve across both roadways and median strip. Here again advanced design thinking is taking exception in all cases where the median strip is not quite narrow.

The new thought is that the four-lane divided highway on curves should be treated like two independent two-lane roads each one crowned to drain to both edges and superelevated independent of the other. Briefly the argument is that it is

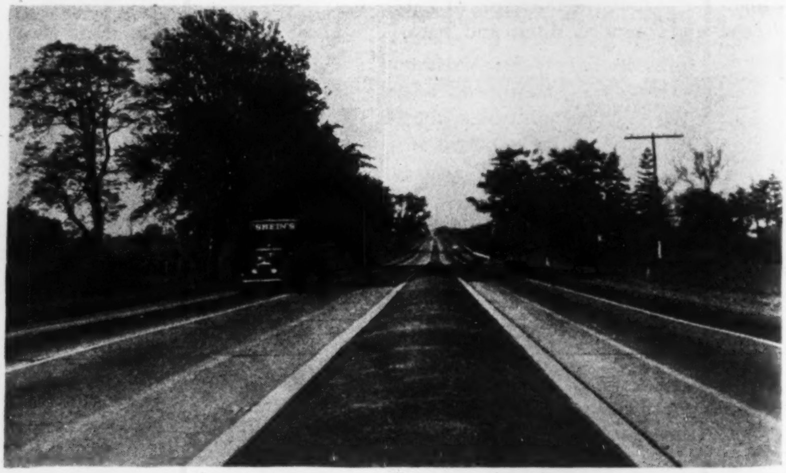


Fig. 6. Brunswick Pike in New Jersey is a fine example of the plain crowned median strip unplanted except for grass; note the inclined curbs made of white cement for greater visibility.

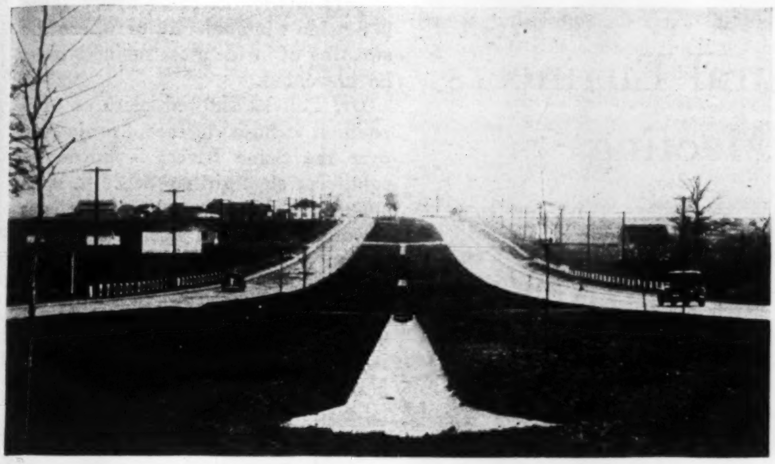


Fig. 7. The Coleman-DuPont Highway in Delaware with a 50-ft. dished median strip set the example for central gutter drainage.

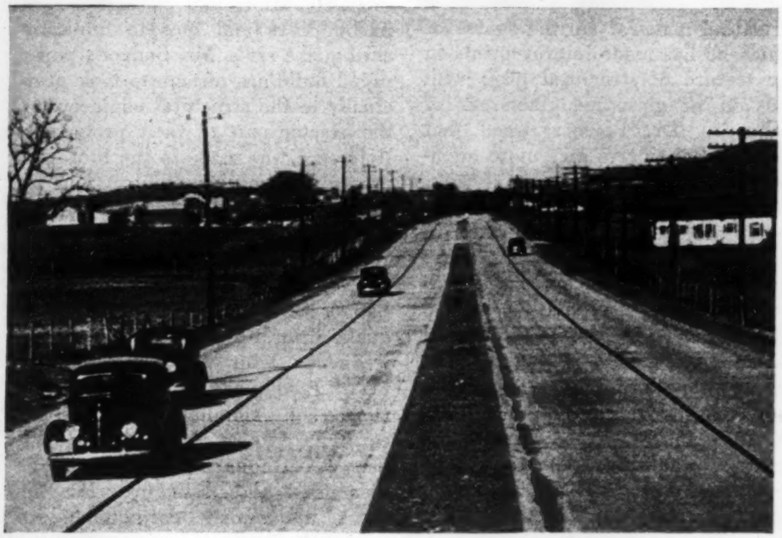


Fig. 8. Four-lane construction in open country represented by this Tennessee road too often crowds the right-of-way.

much easier to superelevate each road of a divided highway independently of the other than to superelevate clear across both roads, particularly if line and grade are worked up for each road. The difficulty in superelevating clear across increases with the width of median strip, a hump or dip in one or both of the roads being almost unavoidable. A pleasing cross-section may be effected by adjusting the profiles around curves so that the outer road is slightly higher than the inner road and the median strip is practically level.

Development of separate elements

Cross-profile dimensions are steadily increasing as the shoulders, roadways, median strip and development of roadside borders have spread out from the center line of the road. About the full range of present dimensions is indicated in Fig. 2. Separately, development and trends are about as follows based on records of the Public Roads Administration:

Median Strips—The surface treatment of median strip areas varies according to the type of median strip used. The selection of hard surfacing or ground cover treatment is dependent upon whether a narrow strip unsuited to the growth of plant life is used or whether a wide strip providing favorable growing conditions without excessive maintenance is available. Normally, the 4-ft. to 6-ft. width of median strip calls for hard surfacing and the 12-ft. to 40-ft. or wider separation indicates the use of ground cover.

Traffic Lanes—The 9-ft. width of traffic lane has practically disappeared from use in the multiple-lane type of highway. The 10-ft. width is most used although its use is decreasing in favor of the 11-ft. traffic lane, and the 12-ft. width is becoming recognized. While the trend is most definitely indicated in favor of the 11-ft. traffic lane at the present time, there are indications that the 12-ft. traffic lane will be more widely used.

Shoulders—The use of three general widths of shoulder on multiple-lane types of construction is indicated. The outer curb in place of a shoulder at first largely used in connection with urban construction projects, appears to have dropped sharply in favor of the wide shoulder. Also the narrower shoulder widths of 2 to 6 ft. formerly used are being replaced by the wider 8 to 12-ft. shoulder. At present 10 ft. is the most common shoulder width, and 8 ft. is the next most used width. A definite trend toward the wider 12-ft. shoulder section is now observed.

Graded Roadbed—Steady expansion has taken place in the development of the divided highway. Widths of graded roadbed have steadily increased from about 60 ft. in 1932, to 72 ft. in 1934, 85 ft. in 1936. Fig. 2 shows the present range and greater widths will gain consideration in the coming 1940's.

Right-of-Way—Widths of right-of-way have increased from 80 ft. in 1932, to 100 ft. in 1934, and 120 ft. in 1936. It is indicated that right-of-way from 200 ft. to 300 ft. wide in the 1940's may become more common in divided highways of balanced design and complete development.

Conclusion

Slowly the divided highway is arriving at a balanced design of cross-profile. The foundation of a well-balanced design is an adequate sectional layout of right-of-way, with roadbed, roadside and adjacent lands all united in proper relation. The divided highways of the coming 1940 decade may be pictured as having a median strip 40 ft. or more wide with a flush-type depressed center, between two 24-ft. one-way surfaces bordered by 12-ft. shoulders, placed on a wide right-of-way with roadside border control.

California Structural Engineers Hold Joint Meeting

Contents in Brief—Los Angeles and San Francisco groups meet together once a year to exchange ideas and discuss current questions. The use of glass as a structural material and the effect of structural engineering on insurance were important topics at the most recent meeting.

TWO ASSOCIATIONS of structural engineers, one at Los Angeles and one at San Francisco, effectively serve the needs of local members and function quite independently except when it comes to legislative matters or whenever there is advantage in joint action. Then there is full cooperation through a state association that has been set up for this purpose. This state body sponsors one joint meeting each year to promote informal interchange of ideas among members from the two parts of the state. At such a meeting held recently at Carmel Highlands, Austin W. Earl, president, Structural Engineers' Association of California, said: "The fact that our two associations are vigorous, independent bodies functioning along parallel lines, rather than as a unit, is a source of strength. Intangible bonds formed by common aims and aspirations are a much stronger link than any central organization ever could be."

In addition to continuing studies of effective earthquake-resistant construction and other advanced methods, President Earl suggested as subjects for current attention the formulation of basic minimum fees, encouragement of activities among engineering students and giving aid to small cities in the improvement of building codes and their enforcement. "There is no way," he said, "in which engineers can so directly gain recognition as by being of use to those from whom such recognition is desired."

From the group of papers presented in busy sessions extending over two days, two have been selected for abstract: "Glass—A Structural Material" by Jaroslav Polivka, research associate in civil engineering, University of California, and "The Effect of Structural Engineering on Insurance" by Henry F. Badger, executive secretary, Board of Fire Underwriters of the Pacific.

Glass as a structural material

Speaking with a background of some 20 years' study of glass as a structural material (in the course of which he has made improvements in the texture of structural glass with the aid of glass manufacturers of Bohemia) Dr. Polivka urged that structural engineers give more attention to this material. Unit stresses, he said, can now be figured at 15 to 20 times the values indicated in strength tables issued a few years ago. He cited tests on 2x2x10-in. prismatic structural glass elements, recently used for several buildings in Europe, which showed bending and tensile strength of 7,200 lb. per sq.in. and compressive strength of 81,000 lb. per sq.in. Toughened glass, whose superior qualities are attained by quick annealing, has tensile and compressive strengths about twice these values.

Unit tensile strength of glass varies with the size of the specimen more than it does in other structural materials. For glass the variations plot into a sort of logarithmic curve; in very small glass threads, down to 0.0003 in. or less in diameter, tensile strength may reach the astonishing value of 1,500,000 lb. per sq.in. These very small filaments are used for efficient diffusion and for heat and sound insulation.

Effectiveness of heat insulation is greatly increased by double glazing, preferably with 2 in. of dead air space, as in hollow glass bricks. A new insulating glass, which uses two layers of clear glass with a central lamina (1/16 to 1/18 in. thick) of glass threads regularly arranged, has a very high efficiency for insulation against radiant heat and sound and is particularly desirable where ther is outside wind velocity or where th sweating of inside glass surfaces mus be prevented.

Dr. Polivka showed pictures of pavilion whose terrace, projectin over the Seine River, is borne b cantilever steel girders of 26-ft. spa connected by a curved balcony girde in which toughened glass is used successfully in the open webs despite girder deflections of 1½ in.

Glass is destined to have a tremendous influence on building in the near future, Dr. Polivka said, and best results will come from the collaboration of structural engineers with glass technologists.

Earthquake insurance

In discussing earthquake insurance rates, conditions that increase hazard in buildings and how to minimize earthquake risks, Mr. Badger's paper urged buildings owners to look principally to the structural engineer for the greater part of their protection. Reference was made to the thorough groundwork on this subject laid by Edwin W. Bannister, which was summarized in *Engineering News-Record*, June 30, 1927, p. 1,052.

Fire insurance companies, Mr. Badger said, carry most of the earthquake insurance and, because of the frequency with which fires follow severe earthquakes, there may be serious and simultaneous fire and earthquake losses. An insurance company's earthquake risks cannot be diversified as can its fire risks because, unlike fires, earthquakes are not checked by fire walls or open spaces nor do building zones control them. Proper design can greatly reduce rates, and he pointed out that provisions for a horizontal force of 0.1*g* is widely recognized as a reasonable precaution to minimize damage.

While the level of earthquake insurance rates is largely hypothetical due to the limited loss experience and is subject to change, it has remained practically constant since 1928. Within the rate levels established, individual building rates vary widely in accordance with the degree of earthquake resistance, soil conditions, special hazards such as unbraced elevated tanks, excessive dangerous ornamentation, and other factors. The demand for earthquake insurance has not varied greatly for some years, although a major shock is usually followed by a large increase in number of applications.

A number of examples were cited to show how various construction types differ in earthquake insurance ratings. Two of these examples are summarized:

(1) A five-story fire-resistant concrete school or office building costing $150,000 might be expected to carry $100,000 in earthquake insurance. For a given location, the three-year premium on this might range from $800 down to $260, a variation of $540 due wholly to the extent to which earthquake-resistant features were included in the original design. The annual difference, capitalized at 5 per cent, amounts to $3,600.

(2) A one-story market or garage, floor area 50x100 ft., costing about $15,000, with hollow tile bearing walls without provisions for resisting lateral forces would take a 3-year rate of $5.00, that is a premium of $225. If this same structure were built of reinforced concrete specifically designed to resist lateral forces, the three-year rate might be as low as 40¢ or only 10 per cent of the cost for insuring the other type of construction.

While "use and occupancy" or "business interruption" insurance is of importance to an owner, assured structural safety is of even greater importance. An earthquake may completely interrupt, if not destroy, the business of a community, and those who can open up the next day, due to foresighted inclusion of adequate resistance in their buildings, would be in an enviable position compared with those who had only an insurance compensation.

Telephone Conduits Carried By Suspension Bridge

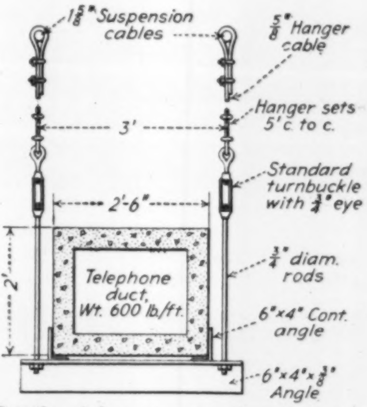
In preparing the foundations for the new Bankers Life Company home office building in Des Moines, Iowa, (*ENR*, Oct. 26, 1939, p. 549) the contractor utilized a suspension bridge to support a long section of telephone cables in concrete-encased conduits while he excavated and built a concrete wall under the line. The conduits, in a concrete box 2 ft. high and 2½ ft. wide, lay just under the surface of a street that was closed and included in the building site. A basement wall was designed to support the conduits eventually, but the contractor had to figure out some way temporarily to support them, without moving or damaging the cables which serve transcontinental circuits. The suspension plan was adopted after considerable study.

The encased conduits weighed 600 lb. per lin. ft. As a basis of design, the contractor figured on two cables, each loaded 500 lb. per ft. Two four-post wooden towers, 29 and 31 ft. high, were erected on 12x12-ft. timber pads in pits 4 ft. below top of box. The towers were spaced 180 ft. apart, well back of each end of the 148-ft. excavated length of wall to be built.

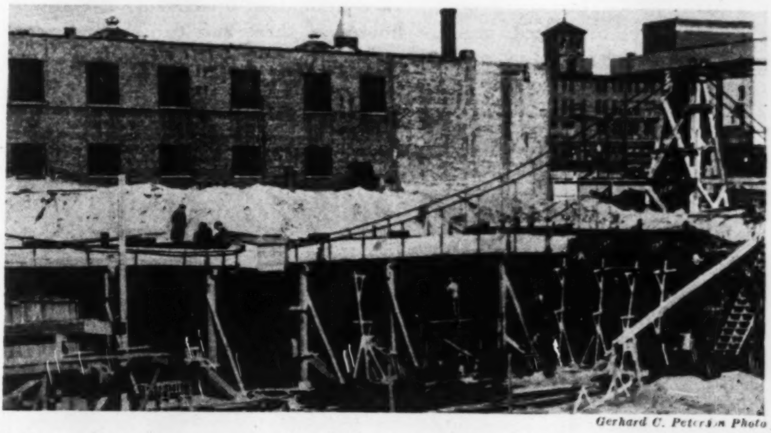
Two 1⅝-in. suspension cables, 3 ft. apart, were hung from the towers, sagging to just below top of box at center of span, and continued over the towers as backstays anchored to deadmen. Each cable was figured for a pull of 94,000 lb. over the suspended span, and 105,000 lb. as backstays. Hanger ropes of ⅝-in. cables were hung from the suspension cables every 5 ft., fastened by clips to the main cables at the top and to turnbuckles at the bottom. Cable clips on the main cables kept the hangers from sliding toward the sag.

A continuous 6x4-in. steel angle was placed under each lower corner of the box as a stiffener and bearing for the supporting cross struts. The struts were 6x4x⅜-in. angles, placed transversely under the continuous angles at hanger points. Struts and turnbuckles were connected by ¾-in. rods, threaded at the upper end and bolted through the outstanding flange of the struts. By tightening up the turnbuckles, the entire load was transferred to the cables before the supporting ground beneath was disturbed.

Arthur H. Neumann & Bros., Inc., of Des Moines is general contractor, with Harold Neumann superintendent in charge.



Details of hanger connections and conduit support.



Gerhard C. Peterson Photo

Cables support concrete-encased telephone conduits during construction of wall below. A manhole in the conduit near center of span complicated the job.

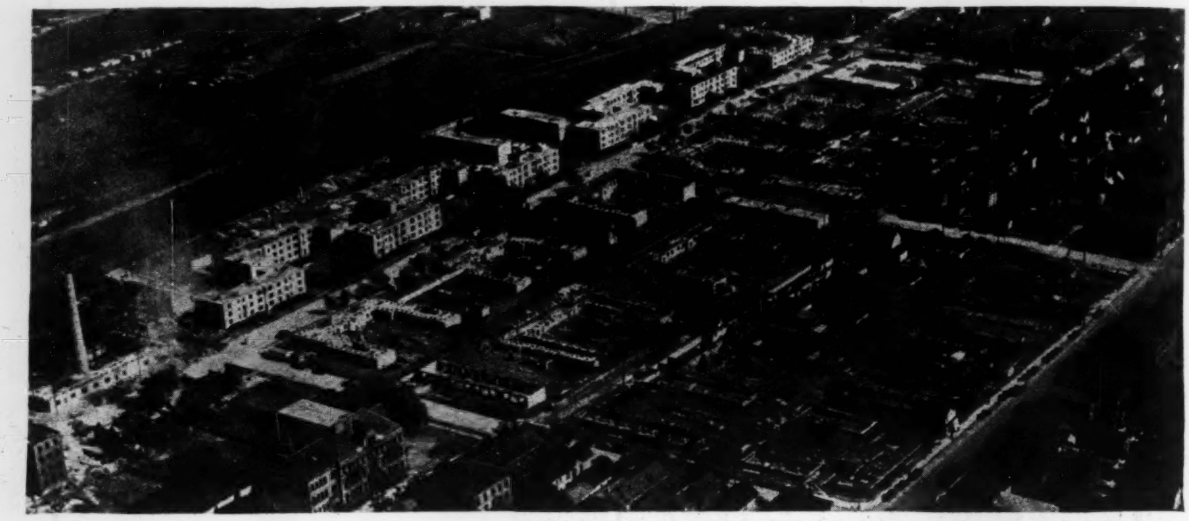


FIG. I. JOB ORGANIZATION IS BUILDING BUFFALO'S COMMODORE PERRY HOUSING PROJECT IN FAST TIME.

Close Coordination Speeds Buffalo Housing Project

***Contents in Brief**—Highly efficient job organization is resulting in fast, smooth-working construction operations on the 50 buildings of the Commodore Perry low-rent housing project being built in Buffalo. Costs are compared on three Buffalo housing developments.*

IN BUILDING the Commodore Perry slum clearance housing project in Buffalo, the John W. Cowper Co. has worked out a smooth-working construction procedure that clicks from start to finish. The job includes 49 two-story and three-story row houses and apartments and a central heating plant carefully laid out on a 29-acre site. Well-organized crews, each assigned to a definite task, move from unit to unit on definite schedule. Always—and this is probably the key to the whole construction operation —they find all materials neatly stacked ready for use. There is no waiting for brick or tile—the material is right on hand, efficiently distributed for fast work.

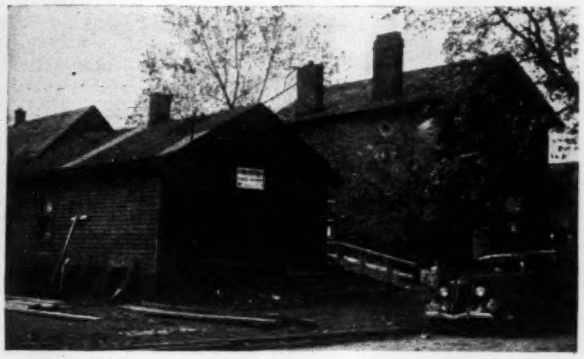
The general contract, not including mechanical and electrical trades awarded separately, amounts to $2,241,965, and must be completed in 450 calendar days. As the contract was let June 20, 1939, completion date is Sept. 12, 1940, but the contractor has set up a schedule to complete the job about three months earlier. Despite delays in obtaining right-of-way, the job is about on schedule today.

Included in the 49 residential buildings are 23 three-story apartments, 14 two-story row houses and 12 combination apartments and row houses of three and two stories, respectively. They inclose a volume of 6,885,440 cu.ft. and have a floor area of 659,400 sq.ft. There are 3,214 rooms divided into 846 dwelling units, or an average of 3¾ rooms per unit. The units average 780 sq.ft.; rooms average 205 sq.ft.

Brick and concrete design

The general design of building is consistent throughout the project, though there is some variation in size of building and room arrangement and size of dwelling unit. Some of the buildings are rectangular, others are U-shaped in various forms. All, however, are 26 ft. 4 in. wide. They have brick and tile bearing walls, reinforced concrete floor slabs, and 2-in. concrete roofs on high-rib metal lath over bar joists. A concrete beam longitudinally through the center of each building, supported on concrete columns, breaks the floor slabs into two 13-ft. spans. Partitions between apartments or dwelling units are hollow tile; between rooms are plaster on metal lath. Windows are steel casement throughout, set in steel frames, with steel lintels and aluminum sills. Entrance doors to each apartment are kalamein; pent house and incinerator room doors are fireproof tinclad; all other doors are wood with pressed steel jambs. Exterior doorways are trimmed with limestone.

There are no basements, except for small incinerators in each building; the first floor is carried above natural ground level. Foundations consist of concrete walls on spread footings, and concrete footings under the columns. On all sides exposed to the street and on all fronts, the exterior is a low-cost face brick; other walls are hard-burned common brick. This



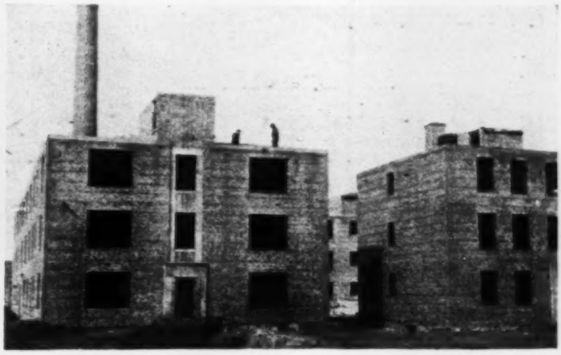


Fig. 2. Transformation of a blighted residential area is evident from these views of old and new structures.

face brick, costing only 50¢ more than the common, is treated on one edge and both ends with a spray of fire clay and sand as it comes out of the mold, giving an attractive lustrous sheen to the face. Upon delivery to the job, the face brick is stacked, while the common is dumped from the truck, which largely accounts for the difference in price.

Interior finish is plaster throughout, applied to the outside tile walls and to metal lath hung from the ceiling slab. Prior to plastering, the inside face of all outside walls is dampproofed by spraying with asphalt. Metal ceiling lath for the top floors is fastened to the underside of the bar joists. All water pipe is brass and stairs are steel. The finished floors will be battleship linoleum in the kitchens, and asphalt tile in living rooms, both laid directly on the concrete slab. Bathroom floors are ceramic tile.

The coping is unusual. It consists of a 2 x 10-in. painted plank, bolted to the bar joists, lapping down over the brick wall and extending above the roof slab. The plank is covered with sheet copper, flashed into the built-up paper and gravel roof and extending down on the face to cover the joint between the wood and brick. Another interesting detail is a vertical copper expansion joint built into the exterior walls at the interior angles.

Construction procedure

Plumbing, heating and electrical work are under separate contract. Cowper does the bulk of the remaining work with his own forces, subletting the demolition of existing structures, painting, plastering, roofing and glazing.

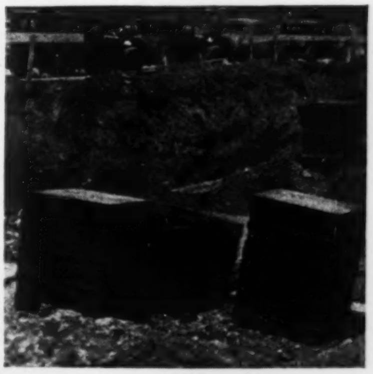
First operation, of course, was the removal of the old frame and brick structures down to sidewalk level. The demolition subcontractor removed the wrecked material from the site. Delay in obtaining certain tracts disrupted the construction schedule for a while, but the job procedure is flexible enough to keep general progress well up to the planned speed. One advantage was the permission to close four streets passing through the site.

In general the construction plan was to start on the buildings in the north group and work along the full length of plot to the south. This plan was modified somewhat because of delays in securing right-of-way.

A power shovel and two clamshell cranes handle the excavation. The shovel is worked down through a group of foundations, cleaning up the general lot excavation and filling in old cellars. Very little excavated material is removed from the site, as most of it can be used for backfill. Following close to the shovel is one or both of the cranes digging out the footings. While the clamshells dig wider trenches than is necessary, the saving in hand labor more than offsets the cost of extra excavation and backfill.

The foundation wall forms are 2 x 3-ft. panels of plywood held together by steel frames. Ties are flat steel bands held by keys that also hold the steel frames together. Odd size panels are available for filling out the wall length and height if necessary. On this job the forms are good for 20 to 30 uses before the plywood needs replacing. Neat piles of form panels are always ready when the carpenters move in.

All concrete is handled by two crews, each having a 1-yd. paving mixer and a crawler crane with a 1-yd. roller bottom dump bucket.



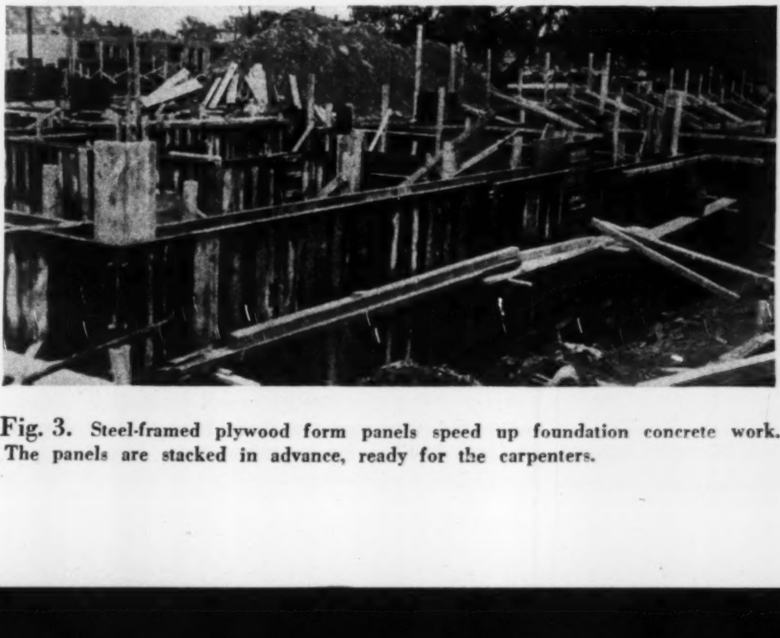
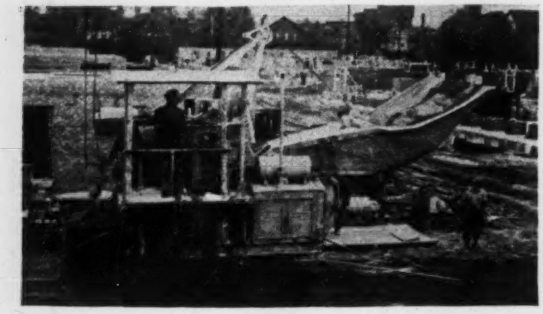


Fig. 3. Steel-framed plywood form panels speed up foundation concrete work. The panels are stacked in advance, ready for the carpenters.



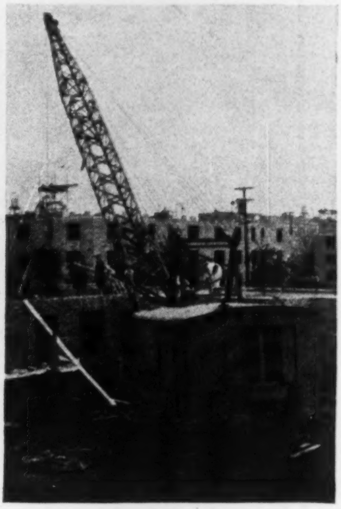


Fig. 4. Concrete for the entire job is mechanically handled. Mixed in a paver, concrete for both foundations and floors is placed by crane and bucket.

The narrow width of buildings permits spotting the mixer and crane within reach of all forms. Aggregates come to the mixer, already batched, from a commercial concrete plant; bag cement is added at the mixer. All concrete is placed by crane and bucket. External vibrators are used throughout.

Following the pouring of the foundations and first floor slab, is the construction of the exterior walls for the first floor. By the time the masons move onto a unit, the advance guard has already stacked piles of brick, tile and window frames on the floor slab, within easy reach of the masons, and the carpenters have the door bucks set up and temporarily braced. Mortar, a 1:1:6 mix, is prepared in one of several mixing plants scattered throughout the job, and is delivered to the masons in wheelbarrows. Cowper is turning out an excellent job of masonry. In fact, both masonry and concrete are of the highest quality and workmanship, equal to that on many much more expensive buildings.

As soon as the masons have the first story inclosed they move to another unit and are followed by the carpenter gang that builds forms for the second floor slab and interior columns. Working along with the carpenters and the reinforcing setters are workers of the electrical, heating and plumbing contractors roughing in their own trades. Right here is where the job could go wrong—but it doesn't. While Cowper has no control over the other three contractors, and any delay on their part would upset the general construction schedule, actually there is not the slightest hitch. The three mechanical contractors find it much to their advantage to work right in with the general contractor's schedule, gearing their operations with his.

The second floor concrete slab and columns between first and second floors are poured together. By the time the slab is ready for the walls above, a gas-driven skip hoist has been set up alongside the building to handle materials for the remainder of the upper floors. In many locations it is possible to place one hoist to serve two buildings.

The procedure for each floor is the same as for the first—materials are stacked ahead of time ready for the carpenters and masons, and all concrete is placed by crane and bucket. The various crews are kept intact, and move from unit to unit in logical order, and the same procedure is followed for the interior finishing work. In general, the job is organized as for building a skyscraper, but instead of moving from floor to floor, the various gangs move from unit to unit.

Costs on three projects

The total contract price for the project, including electrical, mechanical and landscape work, is $2,996,219, which amounts to 43.7¢ per cu.ft. or $4.544 per sq.ft. A breakdown of these prices is given in Table I, which also shows similar prices

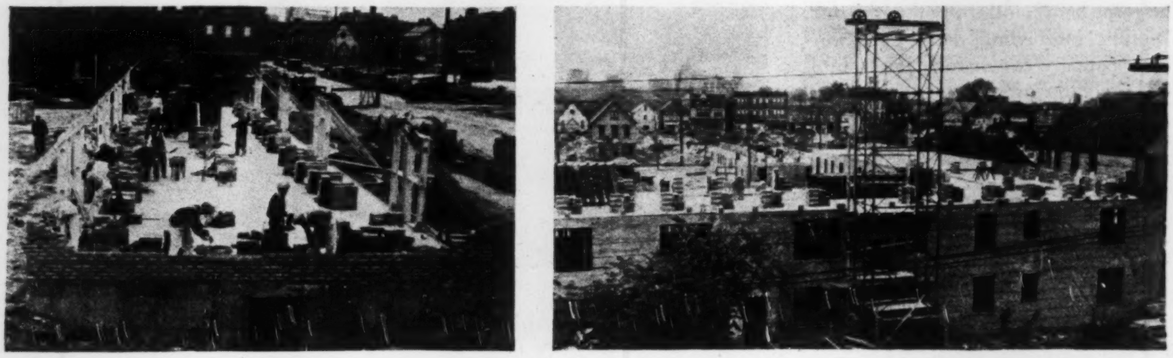


Fig. 5. Materials for masons and carpenters are neatly stacked in advance, as these first and third floor views show. Skip hoists are set up alongside each building for operations above first floor.

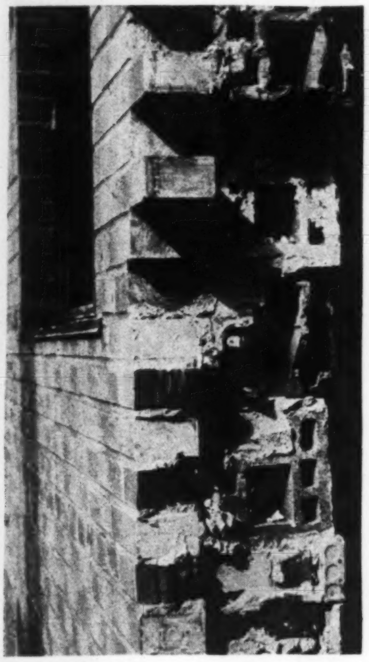


Fig. 6. An example of the excellent masonry found throughout the job, of which the contractor is justly proud.

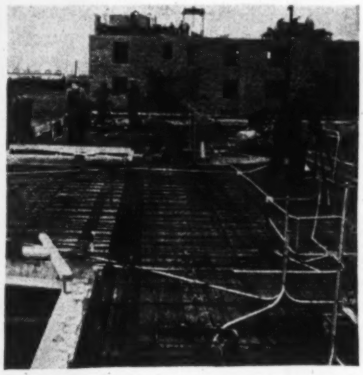


Fig. 7. The mechanical contractors fall in with the general contractor's fast schedule. Here electrical workers are roughing in a floor.

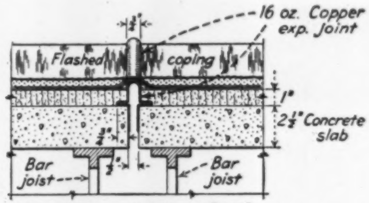
Fig. 8. Advance guard of a fast construction schedule. This man is one of a large crew that keeps materials stacked well ahead of masonry operations.

TABLE 1 — CONTRACT COST COMPARISONS ON THREE BUFFALO LOW-RENT HOUSING PROJECTS

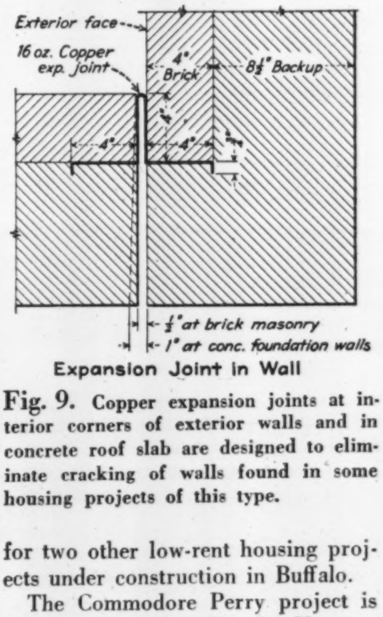
	Commodore Perry	Lakeview	Willert Park
Bid date	Apr. '39	Sept. '38	Dec. '38
Buildings	50	71	10
Volume, cu. ft	6,855,440	5,913,300	1,269,100
Floor area, sq. ft	659,400	599,700	124,200
Apartments	846	668	173
Ave. floor area, s.f	780	890	720
Ave. no. rooms per apt	3.75	4.25	3.5
Rooms	3,214	2,842	588
Ave. floor area, s.f	205	210	210
Total contract cost	$2,996,219	$2,504,179†	$592,000
Per cu. ft	0.437	0.423	0.466
Per sq. ft	4.544	4.175	4.938
Per apartment	3,541.62	3,748.77	3,521.97
Per room	932.09	881.13	1,006.80
General contract	$2,241,965	$1,749,427	$464,635*
Per cu. ft	0.327	0.296	0.366*
Per sq. ft	3.40	2.917	3.479*
Per apartment	2,650.07	2,618.90	2,674.18*
Per room	697.45	615.56	790.19*
Plumbing contract	312,777	341,475	69,000*
Per cu. ft	0.046	0.057	0.054*
Per sq. ft	0.474	0.569	0.556*
Per apartment	369.70	511.19	398.84*
Per room	97.30	120.15	117.35*
Heating contract	263,477	258,277	35,797*
Per cu. ft	0.039	0.044	0.028*
Per sq. ft	0.40	0.431	0.288*
Per apartment	311.44	386.64	206.92*
Per room	81.96	90.88	60.88*
Electric contract	178,000	155,000	43,830*
Per cu. ft	0.026	0.026	0.035*
Per sq. ft	0.27	0.258	0.353*
Per apartment	210.41	232.04	253.35*
Per room	55.38	54.54	74.54*

† Landscaping not included; is included on other two contracts.

* Willert Park let single contract, including mechanical trades; figures marked (*) are for lowest separate general and mechanical bids, given for comparative purposes only.



Expansion Joint at Roof



Expansion Joint in Wall

Fig. 9. Copper expansion joints at interior corners of exterior walls and in concrete roof slab are designed to eliminate cracking of walls found in some housing projects of this type.

for two other low-rent housing projects under construction in Buffalo.

The Commodore Perry project is financed by the U. S. Housing Authority and the Buffalo Municipal Housing Authority. Harry Felton is engineer on the job for the latter. Green & James, Buffalo, are architects. For the John W. Cowper Co., of Buffalo, general contractor, D. B. Neiderlander is general superintendent, and A. Bruce Silverthorn is superintendent. Other contractors on the project are: electrical, Ferguson Electric Co.; heating, Jos. Davis; plumbing, Carl & Grimm.

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Hydraulic Bumper Stops Trains

For stopping trains that over-run the proper stopping point in terminal stations, extensive use has been made in Europe of a type of hydraulic bumper in which the engine or car strikes the heads of a pair of plungers working in horizontal oil-filled cylinders, the oil being forced out through small holes in the cylinder wall and thus opposing resistance to the travel of the piston. In a modification applied recently at a station on the London underground railways, the bumper is mounted on a steel frame which slides in a shallow pit under the track and has shoes riding on the under side of longitudinal beams carrying the track rails. Between these beams is anchored a 15-in. cylinder having its plunger attached to the sliding frame, so that the braking action is a pull instead of a push, the oil escaping in front of the piston as impact pulls the piston forward.

Steel Pile Piers For Railroad Bridges

***Contents in Brief**—To meet requirements of economical and rapid construction at a site requiring unusually long piles the Canadian National Railways designed a bridge pier consisting of closely spaced steel H-piles that serve not only as foundation but as the pier structure itself, being suitably braced for stability and capped for support of the superstructure. The pier has also proved economical and convenient for less difficult locations.*

On recent bridgework of the Canadian National Railways a special type of pier has been developed involving the use of steel H-piles that serve not only as the bearing structure below ground but also comprise the pier structure itself. First used where the piles had to be driven to great depths, the pier proved unusually economical and convenient, advantages which also have been exhibited on later but less spectacular jobs. A typical steel pile pier consists of closely spaced 12-in. 53-lb. H-sections of copper-bearing steel covering the entire area of the pier, and evenly spaced in rows. The tops of the piles are arc welded in the field to 15-in. 33.9-lb. channels, which form a cap for the bearing of the steel grillages used to support the superstructure. Bracing between water level and the pile tops consist of steel angles, also arc-welded to the piles. Temporary jigs hold the tops of the piles in line while the caps and bracing are welded. Supplied in lengths up to 70 ft., the pile sections are spliced when necessary by means of bolted steel plates.

First use of the steel pile pier was for the center supports of the Kinojevis River bridge on the Rouyn branch line recently built into a new mining region in northwestern Quebec. The bridge consists of three 155-ft. through-truss spans and one 75-ft. deck plate girder span. An unusual depth of particularly unstable ground encountered at the location of the central piers made ordinary construction methods such as open caissons, cofferdams or compressed air caissons uneconomical, and study was made of the use of steel H-piles. The steel pile pier was the result.

The average lengths of the piles in the two piers of the Kinojevis Bridge were 175 ft. and 145 ft. respectively. Each pier consisted of 48 piles braced above water level by 6 x 4 x ½-in. angles. Driven with a 7,000-lb. double-acting steam hammer, each pile was designed to carry 30 tons. As the Kinojevis River is used for logging, a steel sheetpile protection crib was driven around each pier. One crib was filled with concrete while the other was merely braced against the pier by welded angle struts.

Another bridge on the same line, across Lake Lemoyne Narrows, consists of a 235-ft. through-truss bobtail swing span, two 90-ft. through-girder spans and trestle approaches. On this structure the pivot pier for the swing span is of mass concrete, but the three flanking piers are all of the steel pile welded type similar to that evolved for the Kinojevis River bridge but consisting of only two rows of 12 piles each or 24 piles.

A third application of the steel pile pier design was in connection with the reconstruction of a plate girder bridge at Portneuf, on the line

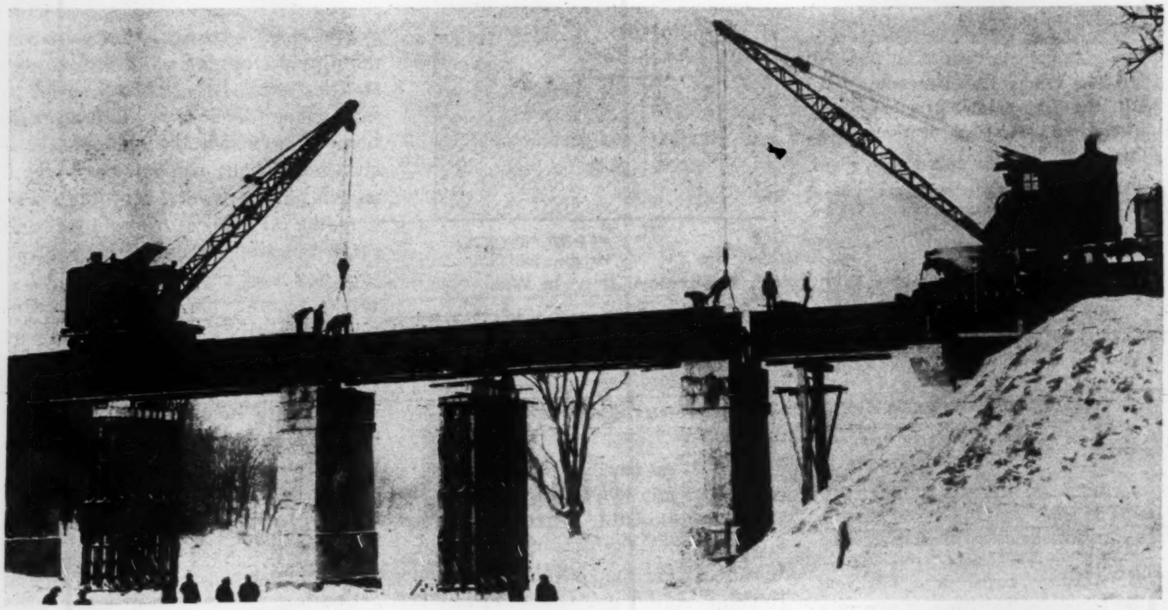


Fig. 1. Start of operations on Nith River bridge to transfer girder spans from old brick piers to new steel pile piers.

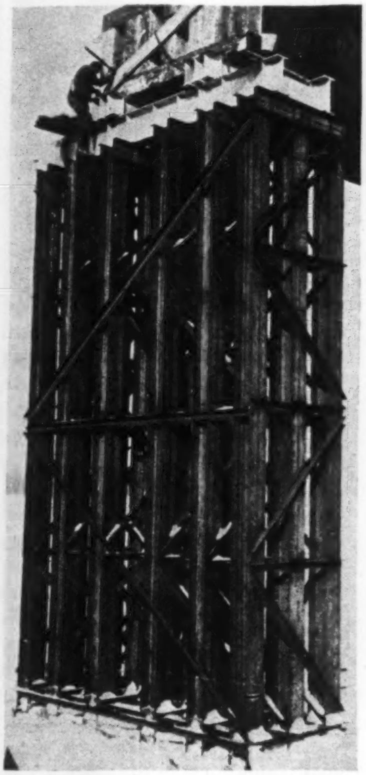


Fig. 2. Steel pile pier as used on the Nith River Bridge in Ontario. Channel caps at top and angle bracing are arc-welded.

between Montreal and Quebec, which was washed out in the flood accompanying the September hurricane of last year. While traffic was carried on a temporary timber trestle, permanent reconstruction was carried out in the following February and completed before the spring floods. The new permanent substructure consists of two new steel pile piers and one new steel pile abutment, the original western abutment and the western pier having been left intact at the time of the washout.

The latest use of the steel pile pier was in connection with the interesting reconstruction, under traffic, of the Nith River bridge in southwestern Ontario, consisting of four 66-ft. deck plate girder spans supported on brick piers and abutments which had deteriorated to such an extent that they required replacement. The reconstruction method adopted involved the construction of two new concrete abutments each about midway between the existing abutment and the first pier, and two new steel pile piers similarly intermediate in position. Thereafter the job was completed by moving three of the existing four spans onto the new substructure, and filling out to the new abutments. Each pier consisted of 18 steel H-piles 60 ft. long; welded bracing above water level consisted of 4 x 4 x ⅜-in. angles as shown in Fig. 2.

The information in this article was supplied by Charles P. Disney, bridge engineer, Canadian National Railways.

Truck Delivery of Supplies Speeds Railroad Construction

TRUCK DELIVERY of rail, ties and fastenings is speeding track laying on a 13-mile section of the Southern Pacific's new 30-mile railroad line around Shasta Reservoir in northern California. Major bridges cut the line into disconnected sections some of which will be inaccessible to standard track-laying equipment until the bridges are completed, hence the completion date for the line, which is a controlling factor in concrete placing at Shasta Dam (*ENR*, Nov. 9, 1939, p. 48), can be materially advanced by laying skeleton track between the bridges while they are being built.

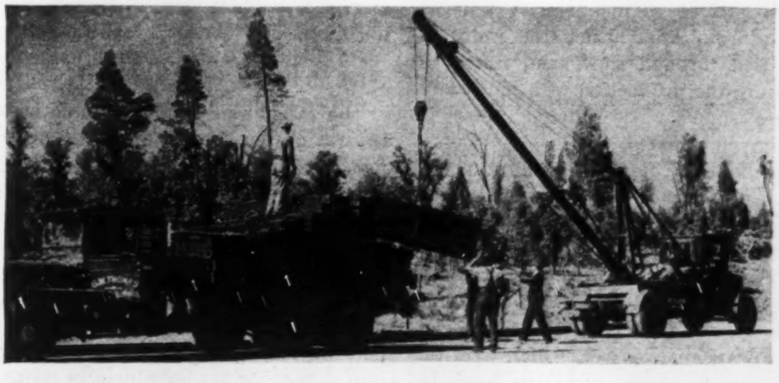
A typical section is the 13-mi. length of line between the first Sacramento River crossing and the large bridge over Pit River. With fills and culverts completed, it is possible to deliver track materials by motor trucks operating on the finished grade. Under this plan as soon as a construction train can be brought over the first Sacramento River crossing it can move ahead immediately to the Pit River job 13 mi. farther on. Because of the greater economy of rail haul, ballast is not included in the track materials delivered by truck.

The roadbed is wide enough to afford space for two rails to be laid at one side, with bundles of ties (12 to the bundle) placed on top, without interfering with use of the roadbed by motor trucks. Two 12-tie bundles are left on each rail length; tie plates, spikes, bolts, etc., are likewise brought by trucks.

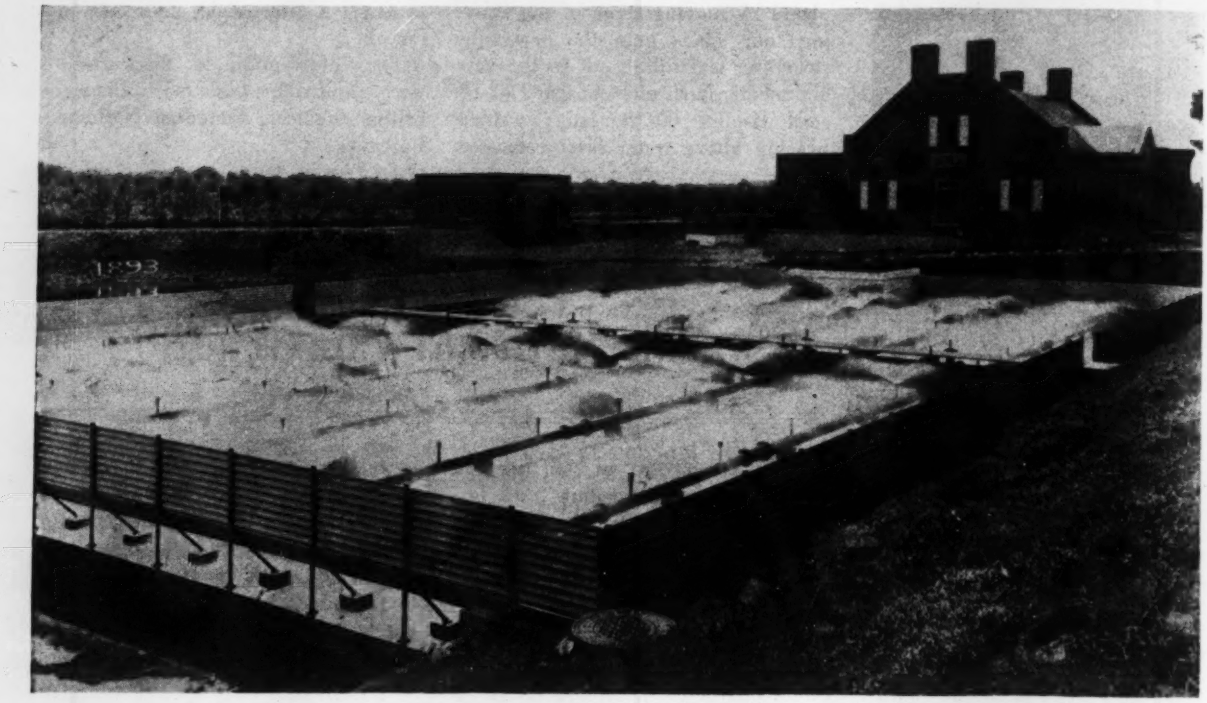
When the ties are loaded on the motor trucks, 2x4-in. strips are used to separate successive groups of 12 thus facilitating the unloading operation of passing a hemp rope sling around each 12-tie group. A power-operated derrick on a motor truck (cherrypicker) does the necessary lifting.

If the plan works out as satisfactorily as is anticipated on the first 13-mi. stretch it is probable that it will be used on portions of the new route beyond the Pit River bridge.

The work is being done under the general direction of W. H. Kirkbride, chief engineer, and J. A. Given, locating division engineer, Southern Pacific Co.



Unloading ties from motor truck in 12-tie bundles. The ties are placed on top of rails previously unloaded at the side of the roadbed.



AERATOR WITH ASBESTOS-CEMENT BOARD FENCE LIMITS SPRAY LOSSES AT LAWRENCE, MASS.

Double Filtration Guarantees Good Water

Contents in Brief*—Continued use of the grossly polluted Merrimack River as a source of water supply was made possible at Lawrence, Mass. by adopting double filtration. New rapid sand filters were built to be used in combination with existing slow sand filtration facilities.

SUCCESSFUL TREATMENT of one of the most heavily polluted raw water supplies of the United States is being accomplished at Lawrence, Mass., using double filtration. Rapid sand filters receiving coagulated water serve as the primary unit of treatment, after which the water is passed through slow sand filters to insure the production of a uniformly safe supply. The filtered water is then chlorinated.

Adoption of double filtration at Lawrence and the improvement of plant facilities followed increasing difficulty in securing a satisfactory water from old slow sand filters, and the proven vulnerability of the plant to flood dangers. The plant is on the Merrimack River, which went on a rampage during the 1936 floods in New England.

Details of plant construction and operation were described by Arthur L. Shaw and E. Sherman Chase, partners, Metcalf & Eddy, consulting engineers, at the Montreal meeting of the New England Water Works Association, Sept. 14. The following extract from their paper deals with the filters and aeration facilities.

Rapid sand filters

The rapid sand filtration facilities consist of ten 1-mgd units, located five on either side of a pipe gallery. The underdrain system consists of 3-in. cast iron pipe laterals 6 in. on centers, with 1/4-in. perforations 6 in. apart in each of two lines about 30 deg. either side of the vertical axis of the underside of the pipe. Each pair of laterals lead through a tee into a concrete header which, in turn, is connected with the filtered water and washwater piping located at the face of the gallery wall.

The sand area of each box is 18x 20.3 ft. Four layers of graded gravel, totaling a depth of 18 in., are placed around and over the pipe grid. Above the gravel is a layer of sand. The sand, which was obtained from the sea near Plum Island, was initially placed to a depth of 33 in. It has an effective size of 0.46 mm. and a uniformity coefficient of about 1.9. About 3 in. of the top will be skimmed off eventually to remove not only foreign matter such as bits of seaweed and shell, but also any excessively fine material which gradually works its way to the top, thus leaving the final sand depth at 30 in.

Provision is made for washing the filters by backwashing in the conventional manner through an underdrain system and also, as an auxiliary method, by surface washing. The latter is accomplished by a system of pipes connected with nozzles spaced 3 ft. apart in each direction, about 4 in. above the ultimate sand surface. Each nozzle directs one 1/4-in. jet straight down, and four similar jets downward and outward at about 52 deg. with the vertical. The surface wash, as well as the backwash, is controlled by hydraulic valves actuated from the operating table.

Washwater control

Washwater under suitable pressure is provided by either of two 10-mgd vertical centrifugal pumps which discharge through a rate controller. Washwater rates can be adjusted between 24 and 34 in. of vertical rise per minute. An important function of the controller is to avoid upsetting the filter gravel by excessive backwash rate. Special devices are provided so that the washwater rate controller is in the closed position when pumping starts, rather than in the wide open position which rate controllers normally assume when there is no flow. This provides insurance against the occurrence of excessive rates in the short interval before the controller can throttle down from the normal wide open position.

A low head spray aerator, through which the filtered water can be passed when taste or odor conditions require it, is provided for the water prior to secondary filtration on the slow sand filters. Spraying is accomplished by 70 nozzles, and the concrete floor of the aerator is sloped to conduct the water falling on it to an outlet.

The nozzles operate under a head of about 4 ft., and at that head have a capacity of 100 gpm each. The water enters the aerator through a header to which 12 laterals are connected. The nozzles are mounted on the laterals, each of which is controlled by a valve, so that the number of nozzles in service can be proportioned to the rate of filtration.

Aerator on filter roof

The aerator floor was constructed by first covering a portion of the concrete roof of one of the covered slow sand filters with 3 in. of corkboard bedded in and flush with hot asphalt. The insulation is provided to avoid freezing of the water on the filter beneath. Concrete of varying thickness was placed on top of the insulation to give the desired slope for drainage. The aerator is surrounded by a fence of corrugated asbestos-cement boards. A sloping apron at the bottom of the fence limits loss of water as wind-driven spray while admitting air freely for ventilation and dissipation of odors released within the inclosed area.

No changes were made in the old covered slow sand filters except to reconnect the inlet to receive effluent from the new rapid filter plant, and to partition off one corner of one filter for conversion into a small filtered water reservoir. This reservoir is intended only to take up the surge of pump demand until the inertia of initial or increasing flow through the slow sand filter is overcome. The slow sand filters occupy an area of about 2.25 acres, and at the 10-mgd rate of flow the water dosage is 4.4 mgd per acre.

Taste and odor removal

In view of the large quantity of organic matter in the river, the occasional growth of algae and the presence of phenolic waste from gas works, it has been one of the important functions of the new treatment processes to remove taste and odor-producing substances. This has been accomplished in part by the basic coagulation and filtration processes, and in part by the occasional use of activated carbon. Most of the time it has not been necessary to use carbon and at no time has aeration been required, although it has been used to some extent.

Provision is made for chlorination of the raw water at the mixing tanks, of the settled water ahead of the filters, of the effluent from the rapid filters, and of the final effluent at the main pumping station. Prechlorination has been carried out practically all of the time, but chlorination of the rapid filter effluent, except when the slow sand filters were not in use, has been seldom employed. Chlorination of the water pumped to the distribution reservoirs has been practiced at all times.

Prechlorination and rapid sand filtration have been adequate to produce effluent of satisfactory bacterial quality. Post-chlorination and slow sand filtration, when used, provide additional measures for safeguarding the supply delivered to the distribution system.

Better Paving Between Tracks For Industrial Yards

GROUTED BALLAST capped with concrete paving for driveways and yard tracks at factories and other industries is described in "Concrete for Railways" (bulletin of the Portland Cement Association) as a marked improvement on the rather common condition of rough and rutted surfaces at such places. Two cases cited are a warehouse and mail-order plant at Chicago, and a manufacturing establishment at Cleveland, Ohio, in both of which the open tracks obstructed the use of the unpaved yards by motor trucks. The method adopted was to grout a new bed of stone or slag ballast and to cover this with a concrete slab finished practically level with the tops of the rails, so that trucks could move and maneuver without difficulty. Guard rails formed the flangeways for the railway wheels.

In a typical case, new stone ballast was laid 12 in. deep under the ties and up to the base of rails. After two weeks under traffic, the track was lined and surfaced and the ballast then filled with a 1:2 cement-sand grout, having 7½ to 8 gal. of water per sack of cement. This grout was made in a paving mixer and poured from a bucket traveling on the mixer boom. Besides the foreman, there were two men at the mixer and four distributing the grout with brooms and shovels. The grouted ballast was sprinkled with water for several days.

A week later, a 6-in. slab of 1:2:3½ concrete was poured, the surface being screeded and trowel-finished to within ¼ in. of the top of rail. High-early-strength cement was used, and calcium chloride for curing. Rail traffic was permitted soon after the grouting, and five hours after the paving was completed.

New York's First Vehicle Tunnel Under the East River

***Contents in Brief**—New York is building twin vehicle tunnels under the East River to relieve congestion on the present bridges. This article outlines the factors controlling the location and tells how the approaches are laid out to meet traffic needs. Also given are details of the tunnel design. A subsequent article will describe the difficult construction work.*

BRIDGES HAVE BEEN USED to facilitate vehicle crossings of the East River at New York since the Brooklyn Bridge was built in 1883, five bridges having been built in about fifty years. In the congested midtown district the 30-yr.-old Queensboro Bridge has been overloaded almost since the time it was put into service, and despite the addition of an upper roadway congestion continued to grow steadily worse as the years went by. In 1936 some relief was furnished by the opening of the Triboro Bridge two miles north, but Queensboro Bridge traffic continued its increase in spite of this relief and during the current year will equal its peak of 1933 with a total of 36,000,000 vehicles, or a year-round average of 100,000 vehicles per day.

A bridge at 14th St. was one of the first proposals for an additional crossing. Later, however, the relation of a new crossing to the midtown business center was recognized, and as early as 1926 a plan for a tunnel near 38th St. and a crosstown underpass was outlined. Other plans were proposed in 1929 and 1931, but depression finances made their realization impossible. After creation of the PWA by Congress in 1933, however, new possibilities appeared, and in 1935 the state legislature established the Queens Midtown Tunnel Authority to build a self-supporting toll tunnel under the river. Early in 1936 this body succeeded in obtaining a PWA grant and loan sufficient to build the tunnel, and under an amended act and its new title of New York City Tunnel Authority it proceeded to carry out the project.

Shortly after the creation of the authority, a plan for a bridge to provide the desired crossing was studied by other city agencies. It was supported by cost estimates of 30 to 35 million dollars against 55 to 60 million dollars for the tunnel. The legislature, however, failed to authorize the change from tunnel to bridge, and the only effect of the proposal was to delay the progress of tunnel planning, so that construction did not begin until Oct. 2, 1936. Since that time progress on the work has been rapid.

Physical limitations

The initial problem, in some respects the most serious one involved in the whole undertaking, was that of working out the best location of tunnel and approaches. Business and traffic growth called for a midtown location, and both the Lincoln tunnel under the Hudson River at 39th St. and the approach possibilities in Queens dictated a location near and south of 42nd St. The Steinway tunnels of the Interborough Rapid Transit Co. at 42nd St. and the four Pennsylvania Railroad tunnels at 34th St. further limited the position of the river crossing within this region. Since both 34th and 42nd streets are main traffic arteries, approaches located about midway between them were desirable.

At this point of the planning other conditions combined to make the Manhattan approach location the controlling problem. West of Third Ave. the ground rises sharply, land costs are high and street traffic is so dense as to prohibit the addition of tunnel traffic. But it was impossible to rise from tunnel depth to the surface east of Third Ave. without excessively steep grades unless the line could be developed in length. The early tunnel projects therefore adopted a helical approach loop. After exhaustive study of the conditions and development of many alternative schemes, Ole Singstad, former chief engineer of the Holland Tunnel, who had been retained by the New York City Tunnel Authority as chief engineer for its project, found that more favorable development could be obtained by swinging the tunnel line in a large curve northward from plazas near 37th St. and Second Ave. to a point between 41st and 42nd streets, and thence crossing the river to a point in Queens about opposite 38th St. This location was adopted as combining a suitable plaza and approach layout with a satisfactory location of the under-river structure at the desired tunnel grade limits of $3\frac{1}{2}$ per cent rising and 4 per cent falling.

In detail the location of the Manhattan land section of the tunnel was

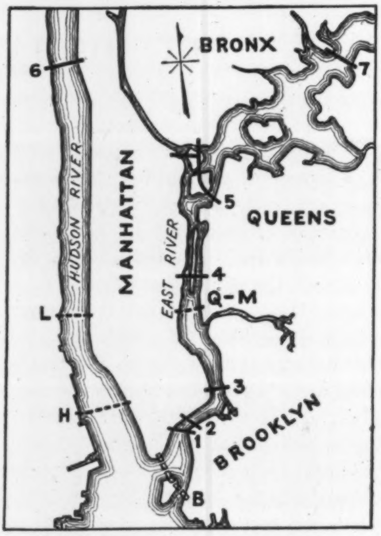


Fig. 1. **An important additional link between Manhattan, Queens and Brooklyn is provided by the Queens Midtown Tunnel.**

restricted by important buildings on the east side of First Ave. at 41st St. and on the west side at 38th St., necessitating curves of 500-ft. radius (a short length has 450-ft. radius). While sharper than desired, these curves were considered acceptable.

All of the tunnel curves are spiraled, and all grade breaks are eased by parabolic curves.

Traffic distribution

Approaches were recognized as the heart of the traffic-link problem. Accordingly they were studied with more care, if anything, than the tunnel itself. On the Manhattan side, land occupancy made it possible at reasonable cost to develop a system of lateral distributary approaches similar to those previously worked out for the Lincoln tunnel. Separate entrance and exit approaches cut through the blocks southward to 34th St. and north to 40th and 41st St., respectively, distribute the traffic to three north-and-south avenues and eight crosstown streets, and as most of the latter are one-way streets the traffic leaving the tunnel is kept separate from that entering.

Approaches and toll plazas are laid out (on the basis of traffic experience) with three approach and toll lanes per operating lane and merging lengths of 125 ft. minimum. All toll collection will be on the Queens side.

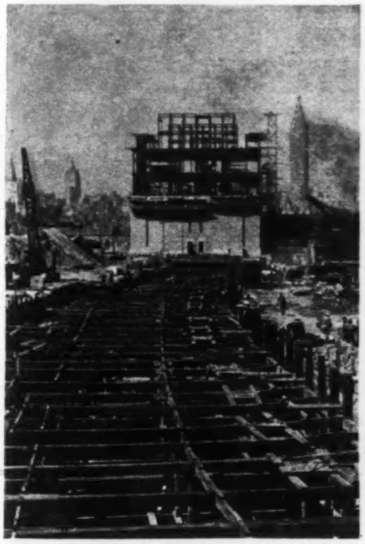


Fig. 2. The land section in Queens is being built in halves in open cut. The second or north half is here shown under construction.

On the Queens side, the problem was not only to supply entrance and exit facilities at the plaza but to open up routes reaching distant parts of Queens, Brooklyn, and outlying Long Island. This approach therefore is essentially an independent highway project, which was worked up by the borough engineers in Queens in cooperation with the tunnel authority and is being built by the city. It comprises an elevated highway extending out Borden Ave., connecting at Meeker Ave. by grade-separation structures with an express highway south to Brooklyn and north to the Sunnyside and Astoria sections of Queens. In due course this trunk route will be continued eastward to connect with Queens Boulevard and Horace Harding Boulevard at their junction. By way of Horace Harding Boulevard the tunnel will create a complete express route from Manhattan to the easterly city limits and the highway and parkway network of Long Island.

Design of tunnel

With the location fixed, and successful vehicle-tunnel models at hand in the previously completed and operating Holland and Lincoln tunnels under the Hudson River, design became a matter mainly of applying and further perfecting approved practice. Some comparative data on the three tunnels are shown in the table on p. 55.

Requirements as to roadway, clearances and ventilation air ducts being identical with those of the Holland and Lincoln tunnels, the outside di-

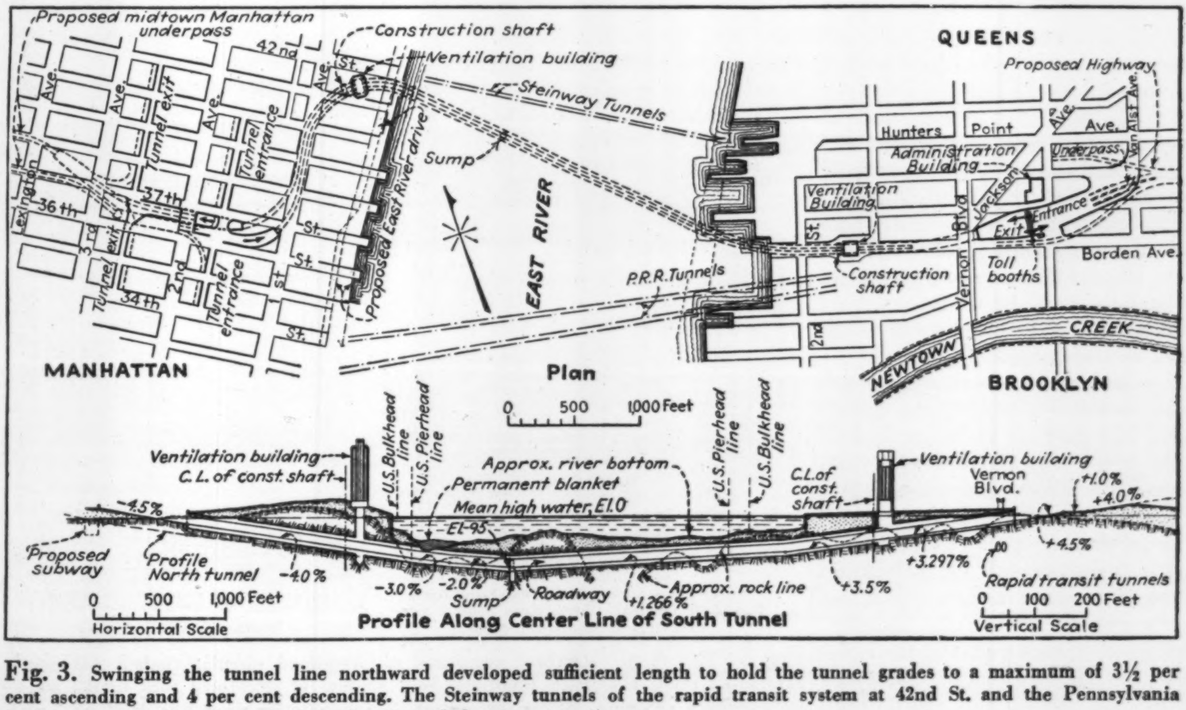

Proposed midtown Manhattan underpass
Construction shaft
Ventilation building
42nd
St.
Ave.
Ave.
Ave.
Ave.
Tunnel exit
Tunnel entrance
Steinway Tunnels
QUEENS
Proposed Highway
Hunters Point Ave.
Ave.
Administration Building
Underpass
Van Alst Ave.
Sump
Lexington
36th
37th
3rd
Tunnel exit
St.
St.
St.
St.
2nd
34th
Tunnel entrance
Proposed East River drive
EAST RIVER
Ventilation Building
Jackson
Blvd.
Entrance
Exit
St.
Construction shaft
Vernon
Toll booths
Borden Ave.
P.R.R. Tunnels
2nd
CREEK
NEWTOWN
MANHATTAN
Plan
BROOKLYN
0 500 1,000 Feet
U.S. Bulkhead line
U.S. Pierhead line
U.S. Pierhead line
U.S. Bulkhead line
Ventilation building
C. L. of const. shaft
Approx. river bottom
Permanent blanket
Mean high water, El. 0
El. -95
C.L. of const. shaft
Ventilation building
Vernon Blvd.
+1.0%
+4.0%
-4.5%
+4.5%
Proposed subway
Profile North tunnel
-4.0%
-3.0%
-2.0%
Sump
Roadway
+1.266%
Approx. rock line
+3.5%
+3.297%
Rapid transit tunnels
0 500 1,000 Feet
Horizontal Scale
Profile Along Center Line of South Tunnel
0 100 200 Feet
Vertical Scale

Fig. 3. Swinging the tunnel line northward developed sufficient length to hold the tunnel grades to a maximum of 3½ per cent ascending and 4 per cent descending. The Steinway tunnels of the rapid transit system at 42nd St. and the Pennsylvania R. R. tunnels at 34th St. limited the location of the river crossing.

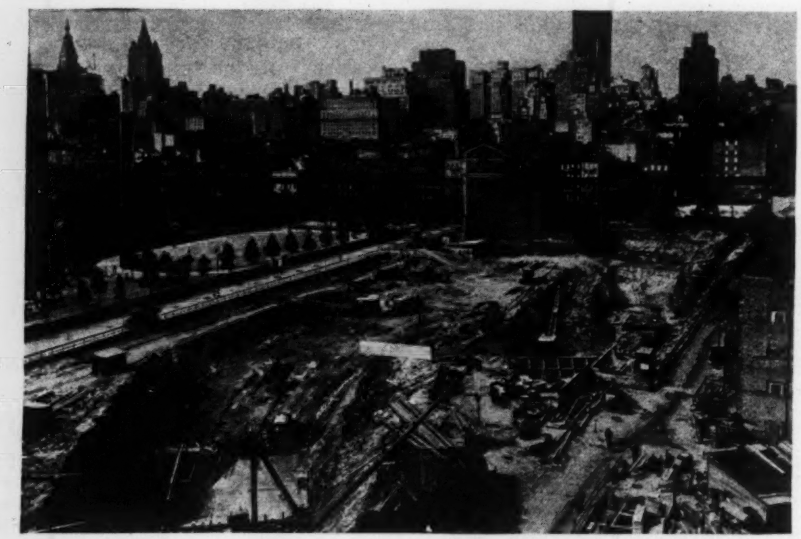


Fig. 4. **Manhattan plazas under construction. The westbound exit plaza is at the right and the eastbound entrance plaza will be at the left.**

ameter was fixed at 31 ft., the same as that of the Lincoln and 1½ ft. larger than that of the Holland Tunnel. On the 500-ft. radius curve landward of the Manhattan shore and outside the shield-driven section, the outside diameter of the lining was made 32 ft. 10 in. to permit of widening the roadway because of the curve. On tangents, a roadway width of 21 ft. was adopted (Holland 20, Lincoln 21½ ft.), and clearance height 13 ft. 6 in. (Holland 13 ft. 6; Lincoln 13 ft. 7½). These dimensions provided the necessary air duct capacity and gave the desired 2-in. minimum cover of concrete over the flanges of the iron lining.

The design of the cast-iron lining or shell of the river tunnel followed closely that of the other two tunnels, as verified by construction and service experience and by deflection tests of some loaded specimen rings of the Lincoln Tunnel. Analyses based on various load and earth pressure combinations were carried out as a check on the design.

Cast iron, which is well adapted to resist the severe loading of the shield jacks, was adopted as lining of the shield-driven tunnel. Precision of placement, rigidity and water-tightness were assured by machined joint surfaces. A heavy type (14-in. flange depth) was adopted for soft and mixed ground, and a light type (11-in. flange) for full rock. No cast steel (used at some points in the Holland and Lincoln tunnels) was considered necessary. For speed and economy of construction a 32-in. ring length was adopted against the 30 in. of the earlier tunnels, and in spite of much more hazardous ground it worked out with complete success. The lining weighs 12.5 and 22.7 tons per ring for light and heavy types respectively.

Bolts (1¾ in. for heavy lining and 1⅜ in. for light lining) are all of carbon-manganese steel, with 85,000 yield point and 110,000 ultimate. Four bolts are used in the longitudinal joints instead of five because experience in building the Holland Tunnel indicated that the longitudinal bolting was excessive and the ring tests at the Lincoln Tunnel confirmed this conclusion.

The floor of the two-lane roadway is a 14 to 15-in. concrete slab embedding 10-in. traverse I-beams generally spaced 21 in., laid with 1-in. crown and paved with 3½-in. vertical-fiber de-aired lug bricks jointed and bedded in bitumen. The concrete floor slab is specified to be laid to ⅛-in. variation in 10 ft., for maximum smoothness of surface. The ceiling is a 5½-in. reinforced concrete slab suspended at the middle of its width by stainless steel hanger rods attached to the iron lining of the tunnel; its lower surface is faced with glass tile of light cream color with pebbled surface held in bronze grippers anchored into the slab concrete by flanges.

Other details of the design include a steel curb plate and improved air inlet and outlet openings. The air inlets, or fresh-air flues, consist of tapering sheet steel tubes connecting the under-roadway duct with outlet openings about a foot above the curb and regulated by an asbestos-fiber adjusting slide over the entrance end of the tube; the continuous longitudinal air channel above the curb used in the Holland Tunnel and in other recently constructed tunnels was abandoned as more costly and less efficient in maintenance. The ceiling air outlets, or exhaust air ports, are cast-iron frames with stainless steel slides for initial adjustment to the pressure distribution in the ducts. The openings in the ceiling are fitted with stainless steel screens.

Steel segment lining was adopted for the rock tunnel land section on

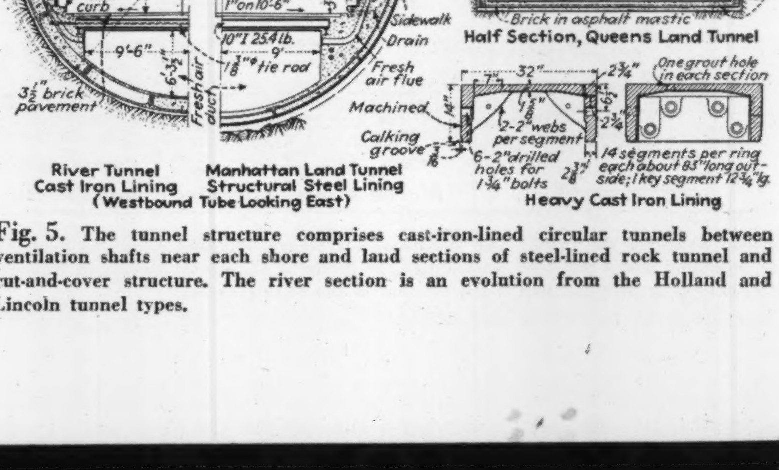

1⅜"ϕ high tensile steel tie rod (at points of special stress only)
Void filled with gravel packing and grout
Payment line 4" outside lining in earth, 9" in rock
Exhaust air duct
Stainless steel hanger
6'-4¼"
16'-4"
Ceiling tile
4"ϕ conduits
Wall tile
6" pipe
13'-6"
31' outside diam.
32'-10" outside diam.
14'
Glazed terra cotta
15½" 2'-8⅜"
10'-6"
10'-6"
Steel curb
Crown 1" on 10'-6"
3'-6"
Sidewalk
Drain
10" I 25.4 lb.
9'-6"
9'
6'-3½"
1⅜"ϕ tie rod
Fresh air flue
Fresh air duct
3½" brick pavement
Machined
Calking groove
3/16
River Tunnel Cast Iron Lining
Manhattan Land Tunnel Structural Steel Lining
(Westbound Tube Looking East)
Brick in asphalt mastic
36" I
3"
13'-2¾"
Exhaust air duct
Fresh air duct
3" hollow tile
Ceiling tile
14" I
Wall tile
13'-6"
19⅛"
4'-0½"
10'-6"
10'-6"
3½" brick
3'-6"
24" to 33" I
¾"ϕ tie rods about 5' ctrs.
8½" brick in asphalt mastic
One ply waterproofing
Brick in asphalt mastic
Half Section, Queens Land Tunnel
32"
7"
2¾"
14"
1⅝"
6½"
2¾"
2-2" webs per segment
6-2" drilled holes for 1¾" bolts
2⅜"
One grout hole in each section
14 segments per ring each about 83" long outside; 1 key segment 12¾" lg.
Heavy Cast Iron Lining

Fig. 5. **The tunnel structure comprises cast-iron-lined circular tunnels between ventilation shafts near each shore and land sections of steel-lined rock tunnel and cut-and-cover structure. The river section is an evolution from the Holland and Lincoln tunnel types.**

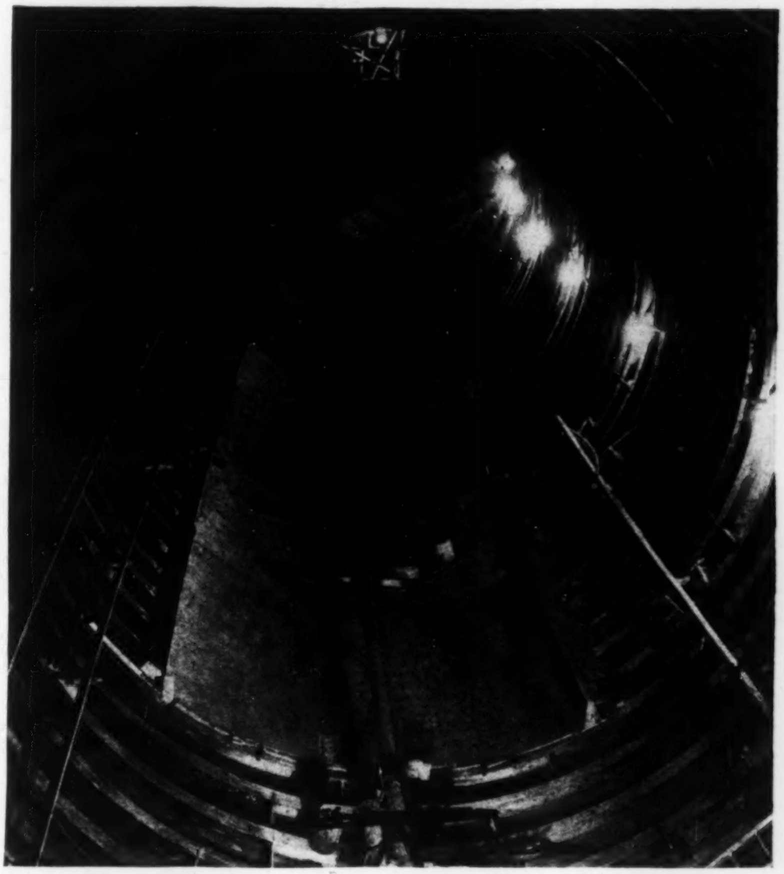


Fig. 6. Concrete lining proceeds in stages, the invert being placed first. Here shown is the westbound tunnel in Manhattan, which is built with rings of welded steel segments.

the Manhattan side as cheaper than cast iron, more flexible, and (where conditions favor its use) tighter, as cast-iron lining sometimes leaks in winter. A 5-ft. ring length was used for this lining, with 11 segments and a key per ring. The segments are welded up of plates and bulb angles and each has a central circumferential flange made of a half I-beam. Faces are not machined, but the joints after bolting are welded to make the lining watertight.

Cost estimates

The original cost estimate for the work, excluding the two approach highways built by borough authorities, was $58,365,000. This was financed by a PWA grant ($11,235,000) and 40-yr. 4 per cent loan ($47,130,000). Contract prices and expected payments indicate that the final cost will be substantially under the allotment. On the basis of a 25c. toll per vehicle and the original estimate of a first-year traffic of 10½ million vehicles, well substantiated by later traffic observations, and capacity operation (16 million vehicles) in the twelfth year, it is believed that all charges will be covered from the beginning and the loan will be repaid well within the bond period.

Planning and construction of the entire Queens Midtown tunnel project is under the direction of Ole Singstad, chief engineer of the New York City Tunnel Authority, assisted by William McK. Griffin, deputy chief engineer. Office and field work are in charge of J. H. Dugan, engineer of design, and Jacob Mechanic, engineer of construction. J. J. Nanry and D. W. Coe are resident engineers. J. H. Quimby is assistant engineer of design, Leo Geenens electrical engineer, Erling Owre architect, H. G. Cruthers mechanical engineer, N. D. Richardson engineer of specifications, and D. G. Baillie, Jr., assistant to chief engineer.

Consultants to the engineering staff included J. B. Snow, the J. G. White Engineering Corp., Gibbs & Hill, Inc., consulting engineers, George L. Lucas, engineer of inspection, Dr. Edward Levy, medical consultant, and Dr. Charles P. Berkey, consulting geologist.

The New York City Tunnel Authority is made up of Alfred B. Jones, chairman, Albert T. Johnson and William H. Friedman. Fearson Shortridge is manager.

The work is supervised by the Public Works Administration through Maurice E. Gilmore, regional director, and R. H. Keays, project engineer.

Details of the difficult operations involved in driving the river tunnels, the principal contracts and the contractors will be given in an article to be published Jan. 4.

COMPARATIVE DATA FOR VEHICLE TUNNELS AT NEW YORK

	Queens-Midtown	Holland	Lincoln
Length, ft.			
westbound	7,865	9,180	(north tube not completed)
eastbound	7,400	9,277	9,652 (south tunnel east and westbound)
Distance between portals, ft.			
westbound	6,414	8,557	7,400 (not complete)
eastbound	6,272	8,371	8,215 (south tube now east and westbound)
Length, under river, ft	3,098	5,480	4,600
Ventilation Buildings	2	4	3
Distance between River Vent. Buildings	3,989	3,374	5,061
Roadway width, min., ft	21	20	21½
Headroom, min., ft. and in	13–6	13–6	13–7½
Diameter, outside, ft. and in	31, 32–10	29–6, 30–4	31, 32–10
Max. grade in tunnels, per cent			
up	3.5	3.50	3.5
down	4.0	4.06	3.5
Max. depth below M.H.W., ft.			
top	73	72	75
roadway	95	93	97
bottom	104	102	106
Cast-Iron Lining, tons	55,300	114,000*	90,500* (2 tubes)
Struct. Steel Lining, tons	4,600	....	4,340 (2 tubes)
Normal Max. Ventilation cu. ft. per min	2,826,000	3,760,000	1,736,000‡
Fans, number	46	84	32‡
Cost	$58,365,000	$48,200,000†	....

* Includes cast steel lining. † Exclusive of interest during construction ‡ Operating one tube

Data from Highway Research

Contents in Brief—Observations and facts voluminously presented in the papers and committee reports of the Highway Research Board at the annual meeting revolved mostly around soil stabilization, financing and earnings and operation. Significant extracts from some of the papers of more general engineering interest are given.

BRIEF SUMMARIES of the many papers presented at the annual meeting of the Highway Research Board in Washington, Dec. 5-8, were given in the news issue of Dec. 14, p. 801 in a running account of what was said in the several sessions of the meeting. As some of the committee reports and papers contained statements that could not be adequately covered in the news report they are summarized here with particular attention to the emphasis of discussion relating to operation, and current problems of toll financing and tax diversion.

MAINTENANCE COSTS

Road maintenance costs in Arkansas, Louisiana, Oklahoma and Texas averaged over a four-year period range for low-type roads from $98 to $577 per mile; for intermediate type from $186 to $249; for high type from $98 to $40 per mile, according to density of traffic. The traffic ranged from 71 vehicles per 24 hr. for lightest-traveled low-type roads to 5,312 vehicles for heaviest-traveled high-type roads. All figures apply to 18-ft. roadway.

Taking construction costs into account, the upper limits of economic maintenance were computed to be $381 per mile per year for low-type surfaces (at a traffic of 265 vehicles per day) and $226 per mile for intermediate-type surfaces (at 750 vehicles).—H. K. BISHOP, *chairman Committee on Maintenance Costs.*

GUARDRAIL STANDARIZATION

In conjunction with the numerous phases of modern highway guardrail, thought must be given to standardization in so far as interchangeability of parts is concerned. Standardization is the only means of placing guardrail in line for competitive bidding and cutting down the number of parts which must be carried by a maintenance organization in order to maintain its guardrail in safe condition at all times; also to provide against the eventuality of a manufacturer discontinuing production, which is happening today.

It is the opinion of the committee that the problem, while complex, is not incapable of solution.—G. A. RAHN, *chairman Committee on Highway Guardrail.*

LEGIBILITY OF SIGNS

Sign legibility studies, made with 6 to 18-in. letters, both wide-spaced and narrow-spaced, black on white, with 412 different observers and a total of about 4,600 different observations, showed that 12-in. wide-spaced letters are as legible as 15-in. narrow-spaced letters. Reflectors reduced the daytime legibility of the smaller letters very little but showed some effect on the 18-in. letters. At night the legibility of reflectorized signs against a dark background was about equal to that of floodlighted signs, but the latter were more legible against a light background.

The legibility distances found indicate that at least 10-in. wide-spaced or 12-in. narrow-spaced letters should be used for warning signs if 10 sec. warning is to be given the driver at 50 mph at night. This assumes that the sign is placed 400 ft. ahead of the hazard, which, with 350 ft. legibility distance, gives a warning distance of 750 ft. With sign placed at the hazard, an 18-in. wide-spaced sign should be used.—T. W. FORBES and R. S. HOLMES, ***Yale Bureau of Street Traffic Research.***

REFLECTION FROM PAVEMENTS

How much light is reflected from different pavement surfaces was investigated in Oregon by field tests on nine actual road surfaces and by laboratory tests on small panels. The surfaces included concrete from smooth steel-troweled finish to ribbed or grooved finish, several different asphalts or asphaltic concretes and oiled macadam. Beams of light were directed on the surfaces at incident angles ranging from 2 deg. 45 min., to 45 deg., and with the steeper angles the reflected light was measured at 15-deg. intervals around a 180-deg. horizontal arc. Both dry and wet surfaces were tested.

On dry pavement very little specular reflection or glare was found on any surface. The portland cement concrete pavements gave a practically uniform reflection in every direction, and in general were about four times more luminous than the darker asphaltic pavements. The latter showed a slight tendency toward more intense reflection away from the light source than toward it. The rough and irregular macadam surface reflected more light toward the source than away from it.

When the surfaces become wet the light reflected away from the source is greatly in excess of the reflection in other directions, this is most apparent on smooth textured pavement, especially the plain asphalt and worn asphaltic concrete.

Under low-angle incidence comparable to headlight lighting, none of the pavement surfaces reflected any great amount of light when dry. The open-type asphaltic concrete and the bituminous macadam gave no more glare when wet than when dry, and the glare from the broomed portland cement concrete was not objectionable. Some of the smoother pavements reflected 20 times as much light when wet as when dry.

Glare from a wet pavement surface is a function of the ability to drain the water away without flooding the surface. The flatter the pavement surface and the heavier the rainfall, the better the drainage must be to prevent glare. The rough-textured surfaces, such as the broomed or ribbed concretes, the open-type asphaltic surfaces, and the bituminous macadam surfaces were satisfactory under the heaviest rainfalls tried.

The same pavement surfaces that gave satisfactory results from the light-reflecting standpoint were the most skid-resistant when wet.—G. S. Paxson and J. D. Everson, *Oregon State Highway Department.*

DATA ON SKID RESISTANCE

Skid resistance tests of a group of 36 representative pavement surfaces on the Oregon highway system include four different general pavement types: Portland cement concrete, asphaltic concrete, bituminous macadam and oil mat surfaces.

The pavements range in age from that laid in 1920 to new pavements laid in 1938 and tested before being subjected to highway traffic. A wide variety of surface textures is included in the test series, ranging from the polished surfaces of overly fat asphaltic concrete pavements, where bleeding of the asphalt has covered the entire surface with free asphalt, and old portland cement concrete pavements worn by 17 years of traffic, to the new, heavily grooved portland cement concrete pavements and the coarse and open textured asphaltic concrete and bituminous surfaces.

The tests were made with a specially constructed trailer towed behind a light truck. A dynamometer was placed in the towing bar to record the tractive resistance of the trailer. The tests were made by locking one wheel of the trailer while a constant speed was maintained by the towing vehicle. The tires used were 5.50 x 17 in. in size, retreaded to give a smooth surface without tread design.

Tests were run at constant speeds of 10, 20, 30, and 40 mi. per hr. on level sections of highway under both wet and dry conditions. For tests on surfaces in the wet condition a sprinkling tank truck was driven ahead of the test vehicle. The main series of tests were made with a wheel load of 800 lb. which corresponds closely to the wheel load of the average passenger automobile.

In general the tests confirm the actual driving experience that any of the pavements are satisfactory at reasonable speeds and under dry conditions. At high speeds and with wet surfaces a wide variation in skid resistance was observed. The smooth and so-called sandy textured surfaces having co-efficients of friction when dry of between 0.40 and 0.60 drop to values in the range of 0.20 to 0.30 and in a few cases to below 0.20. The coarser textured surfaces such as the heavily broomed portland cement concrete, the open type asphaltic concrete, and the newer type bituminous macadam are only slightly affected by water. It was found that the surface textures which permit the draining away of water without flooding the surface are more skid resistant when wet than when dry.

The decrease in skid resistance with increasing wheel load was found to be an important factor especially on dry surfaces. Doubling the wheel load resulted in a decrease in the coefficient of friction of from 25 to 40 per cent on dry surfaces and from 15 to 25 per cent on wet surfaces.—John Beakey, K. M. Kline and W. J. Brown, *traffic division, Oregon State Highway Department.*

HIGHWAYS TOLLS AND FINANCE

Tolls—Tolls are generally recognized today as being an equitable and expedient method of financing bridges and tunnels whose cost would otherwise prohibit construction. The toll gate is unsuited for any large part in the financial plan of modern highways, but there is a legitimate place for the toll structure in highway transportation in so far as it provides a super-service to the motorist. Theoretically, as long as the savings to the motorist by reason of his use of a toll structure are in excess of the toll payment plus motor fuel taxes generated in using the facility, there should be no economic objection to the special charge; no toll facility could be liquidated which did not offset the availability of a competing free road by savings in time and operating cost and by increased convenience.

In recent years the federal government has been actively interested in the subject of tolls as a means of financing highways and bridges. Increasing interest in toll financing has also been evidenced in recent sessions of the state legislatures. While 1939 laws in some cases provide for the freeing of toll structures, the extent to which provision is made for the construction and operation of toll bridges emphasizes that such facilities have a recognized place in present-day systems of highway transportation with growing need for high-cost traffic structures in metropolitan areas and greater resistance to increasing motor vehicle taxes. Toll popularity in the future depends upon whether the achievement of costly super-service roads and structures demanded by the motor vehicle will continue to remain outside the probabilities of ordinary financial methods.

Revenue bonds—Practically nonexistent fifteen years ago, revenue bonds have already won a place of significance in public finance. This popular acceptance may be attributed in part to the fact that revenue bond finance recognizes only the users of a service as responsible for its support. Also, since these bonds are issued only for projects expected to pay their own way, support is given to the careful selection of economically sound projects. Expediency has been a further factor in the resort to revenue bonds, for the absence of any obligation of levy taxes for their redemption and the exclusion of such financing from the public budget have avoided the restrictions of tax and debt limitations.

Revenue bonds for highways issued by the states are secured by a lien on all or part of motor vehicle revenues. In addition many states service general obligation bonds from highway revenues, so that in practice these issues resemble revenue bonds in servicing methods. Another form of revenue bond is that issued by a proprietary corporation or authority which issues bonds to the public on the security of tolls. These so-called agency revenue bonds have been used since 1926 for bridges, tunnels, and recently for highways—the 166-mi. Pennsylvania Turnpike, now under construction. Municipal revenue bonds have been confined for the most part to the provision of domestic services. The present $60,000,000 highway revenue bond issue for express routes in Chicago, however, may mark a new beginning in the attempt to improve the traffic situation in metropolitan areas. California has also made provision for such undertakings.

There are now more than 60 bridges built and operated by an agency representing the public and financed by public revenue bonds. None of these is in default. Revenue bond acts have been passed by nearly all the states, and although many of these are unsatisfactory, the trend toward better enabling legislation may be expected to continue.

Road-tax Diversion—With only one state diverting highway revenues to non-highway purposes in 1921, and only seven in 1929, the depression found lawmakers turning more frequently to the earning capacity of the highways. In 1938 they were obtaining $158,000,000 in 37 states; six states were diverting more than 25 per cent of all highway income.

To date seven states have passed anti-diversion amendments, while in the 1939 legislative session five states took action toward that end and actual diversions were defeated in three states. On the other hand, resolutions proposing to place anti-diversion amendments before the electorate failed or were not acted upon in eleven states, while an anti-diversion statute was voted out in Indiana. The total of appropriations for this year may exceed the 1936 peak; in New York, the general funds will receive $73,000,000 from the motorist, Rhode Island will continue using one-third of the gasoline tax for relief, and Nebraska increased appropriations to the state assistance fund from 10 to 20 per cent of the gasoline tax. Pennsylvania appropriated $11,570,000 from the motor license fund for servicing the state debt.

The successful passage of anti-diversion amendments appears to have established the fact that public opinion favors the use of special motor vehicle revenues for the development and maintenance of highways.—THOMAS H. MACDONALD and WILFRED OWENS, *reporting for Department of Highway Finance.*

PRESSURE ON WALLS

On the basis of a study of the evidence provided by the accounts of previous researches and observations of retaining wall performance as they appear in the literature, the following hypothesis is proposed: The resultant of the lateral pressure on a retaining wall may be considered to be composed of two components; one due to the pressure of the backfill below the level of the top of the wall and the other due to loads superimposed above the level of the top of the wall and adjacent to it, including surcharge fill loads. The first of these components appears to act approximately at the top of the lower one third height of the wall, and the pressure is distributed in a quasi-static manner in accordance with Rankine's analysis for a level backfill. The second component may act at any distance above the base of the wall depending upon the position, both horizontally and vertically, of the superimposed load relative to the wall. The resultant of these two components may act at almost any elevation, depending upon their relative magnitude and position, but will usually act somewhere within the middle one third height of the wall. In general, the greater the magnitude of the superimposed load and the closer it is to the wall, the higher will be the position of the total resultant pressure and vice versa.—M. G. SPANGLER, *Iowa State College, Ames, Ia.*

DELAYS AND GAS COSTS

Two studies were recently made of the effect of traffic delays on gasoline consumption, one in downtown Boston and the other on the Boston Post Road and Merritt Parkway in Connecticut. In the first series of tests seven routes varying from 1¾ to ½ mile in length and totaling 5.46 miles of the most congested streets in Boston were driven over a considerable length of time, both on Sundays and weekdays. Gas consumption on Sundays, when the only delays were traffic lights, showed a mileage of 18.2 miles per gallon while on weekdays the mileage was only 12.1 miles per gallon, reflecting the effect of traffic. On weekdays, for example, it required seven minutes to the mile, of which 2½ min. was for traffic stops, 1½ min. in first and second gear, and 3 min. in high gear. In each mile, 4 to 5 complete stops of ½ min. each were necessary. It was these stops that caused a 50 per cent increase in the gas consumption over that obtained under conditions of no congestion. Since the average daily traffic was about 15,000 vehicles in 12 hours, and assuming gas at 16 cents a gallon, the additional cost for gas caused by congestion was placed at $18,000 per mile per year. Average speed maintained was 8.1 miles per hour.

In the second part of the investigation cars were driven over the Boston Post Road and the parallel parkway known as Hutchison River Parkway in New York and Merritt Parkway in Connecticut. Some interpolation of results was necessary since Merritt Parkway was not completed to a connection with the Post Road, but these interpolations and estimates are believed to be conservative. Between comparable points the Post Road route is 53.48 miles and the parkway route 55.51 miles. To drive the route on the Post Road required 128.1 min. as against 87.7 min. on the parkway or a saving of 40 min. Average speed on the Post Road was 25 mph compared with 38 mph on the parkway. Gas mileage was 18.4 miles per gallon on the Post Road as against 20.1 miles per gallon on the parkway. Assuming a gas cost per mile of 16½ cents per gallon, the total gas cost on the Post Road was 48 cents and on the parkway 45.4 cents or a saving of 2.6 cents.—A. J. BONE, *Assistant Professor of Highway Engineering, Massachusetts Institute of Technology.*

PAVEMENT REDUCES CAR COSTS

Automobile operating costs on concrete pavement and gravel road were studied during 1938 and 1939 in Iowa by running four identical cars about 32,000 miles each, two of them on a 233-mile circuit of concrete road and the two others on a 237-mile circuit of gravel road. The concrete road ranged in age from 17 to less than 10 years old; the gravel road in part was rutted, in part had loose gravel on the surface, and in part was soft and slippery after heavy rain, and in dry weather showed much washboarding and was dusty. The cars were equipped with various performance gages and meters.

At 50 mph the cars on concrete averaged 18 mi. per gal. and the cars on gravel 16¼ mi. per gal. The gravel cars used about twice as much oil as the concrete cars; oil filters, installed on one car of each pair, reduced oil consumption by 25 to 50 per cent. Tire wear on gravel was practically double that on concrete at 25 mph, while at 50 mph the difference was cut in half. Cylinder and bearing wear and brake lining wear were considerably higher for the gravel cars than the concrete cars. All costs, including tire wear and repairs, averaged ½ cent per mile higher on gravel than on concrete. Oil filters reduced these costs by about one-tenth cent per mile on gravel.—R. A. MOYER, *chairman Committee on Operating Costs.*

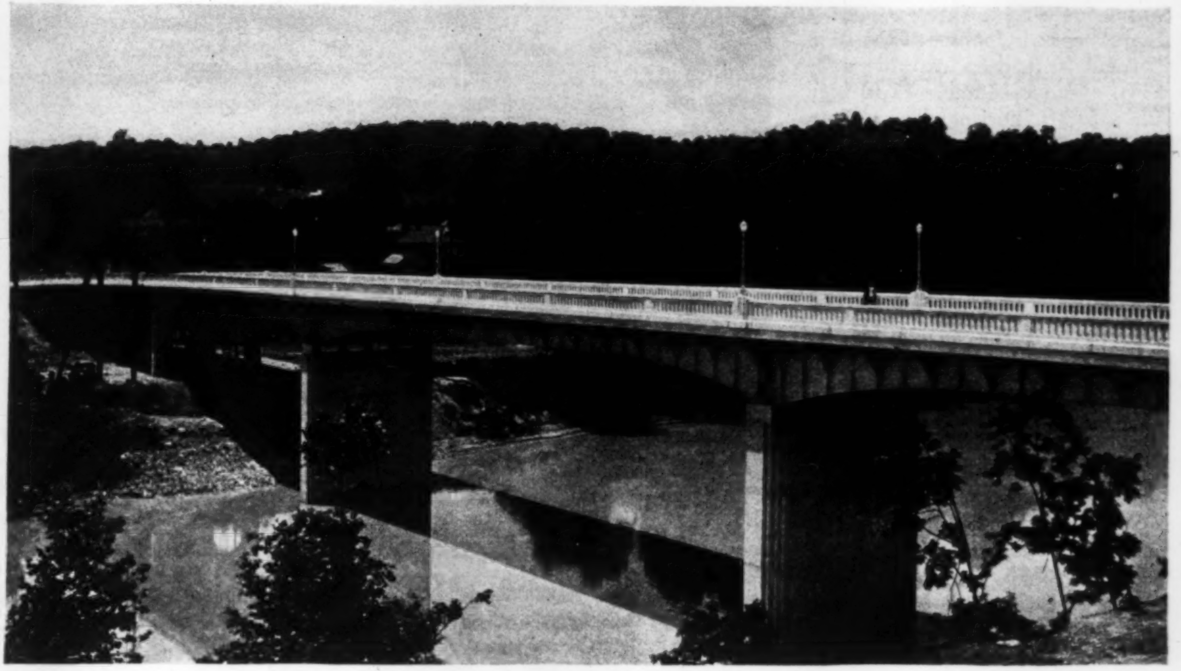


FIG. 1. CAPITAL MEMORIAL BRIDGE AT FRANKFORT, KY., THAT WON THE A.I.S.C. AWARD AS THE BEST IN ITS CLASS.

Building a Beautiful Bridge

E. D. Smith
Kentucky State Highway Department,
Frankfort, Ky.

***Contents in Brief**—Believing that bridges should be ornamental as well as useful, the Kentucky State Highway Bridge engineers started out to design beauty into the new Capital Memorial Bridge at Frankfort. They ended up with a deck girder structure with a three-span continuous unit of 474 ft. that received the American Institute of Steel Construction award for the most beautiful bridge of its class. This article tells how the bridge was built.*

A few weeks ago the American Institute of Steel Construction placed a stainless steel plaque on the Capital Memorial Bridge over the Kentucky River at Frankfort, Ky., designating it as the most beautiful steel bridge of its price class for the year. Naturally, the bridge engineers of the state highway department are pleased with this award, but it was not by accident that the bridge was one of beauty. From the start the designers had in mind the creation of a structure of pleasing appearance, one that fitted into the attractive natural surroundings, and one that added dignity to the approach to the Capitol. The bridge was designed architecturally before it was designed structurally.

The general design is a 3-span continuous deck plate girder with a center span of 200 ft. and side spans of 137 ft. each. This 474-ft. continuous steel deck girder is one of the longest of its kind in the country. In addition to the main span there are three 67-ft. simple deck plate girders on the south approach and one 26-ft. concrete deck girder span, widened and built on a curve, on the north approach. Permanent creosoted timber inspection walks, supported by cross-frames and hangers, were placed between the girders of the continuous unit. The bridge carries a reinforced concrete deck with a 30-ft. roadway and two 6-ft. sidewalks, which are cantilevered on steel brackets and support reinforced concrete handrails. (For further details of the design see *ENR* Oct. 21, 1937, p. 672.)

Foundation construction

The two main river piers were built to rock in steel sheetpile cofferdams without any difficulty. Precast concrete piles, 14x14 in. square, were driven for all but one pier and the abutment on the south bank. The piles were designed for a load of 35 tons, and were driven to a bearing of 70 tons each according to the *Engineering News* formula.

A special foundation was required for pier S-1, located on the south bank about 100 ft. landward from the river edge. Because the river bank at this location had been breaking away and moving toward the stream, it was decided to carry the foundations down to rock. The pier consists of three separate footings, 8x15 ft. in plan and 10 ft. deep, carrying three 5x5-ft. concrete columns 70 ft. high with a 5x3-ft. horizontal strut 5 ft. below ground line, and connected with a cap at top of columns. The footings are 60 ft. below ground level.

A rectangular frame of wales and struts, large enough to surround the three footings, was set up and inclosed by 25-ft. steel sheetpiling. Inside the cofferdam three rectangular bracing frames, one for each footing, were erected, around which 50-ft. steel sheetpiling was driven to solid rock. Bracing was carried down on the smaller cofferdams as material was excavated by a clamshell. The holes were rather wet, requiring two 6-in. centrifugal pumps in each section.

When rock was reached several exploratory holes were drilled 6 ft. or so to determine the soundness of the limestone. In one section of the cofferdam the sheeting had been deflected inward by a boulder, and this hole was refilled with sand and gravel, the sheeting was then pulled and redriven. This was necessary because the cofferdam area, due to the deflection of the sheeting, was smaller than the size of footing desired. Two footings were poured under water with a bottom dump bucket; the concrete contained an additional 10 per cent cement. The third footing was poured dry.

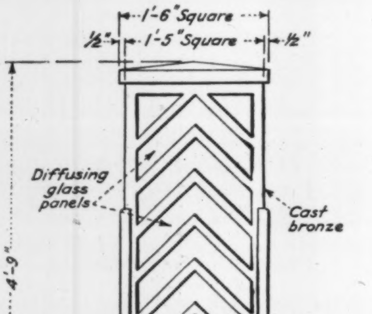


Fig. 2. Special luminaires of cast bronze and diffusing glass panels adorn the entrance pylons.

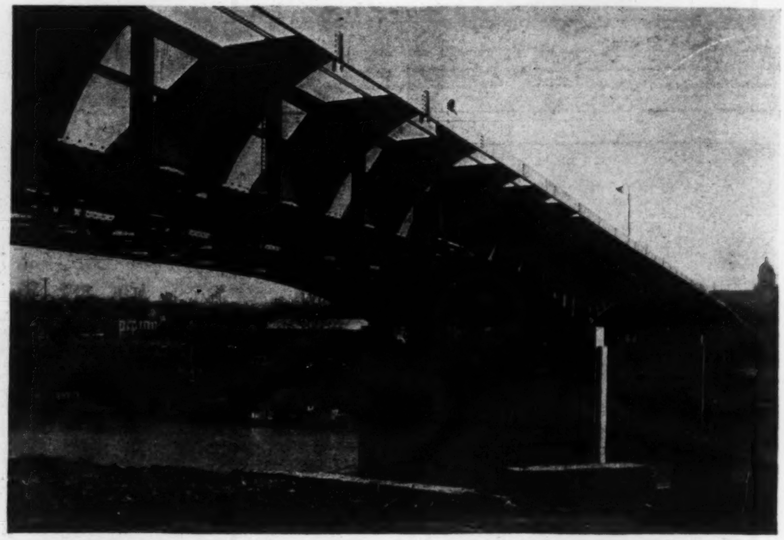


Fig. 3. This view from the north bank shows the graceful curves of the bottom flanges of the five girders in the continuous unit, those of the cantilevered sidewalk brackets and the attractive paneling of the river piers.

CALCULATED DEFLECTIONS		
LOADING	4 POINT ON SIDE SPANS	MIDDLE OF 200 FT. SPAN
Dead load of struct. steel	0.180 in.	0.986 in.
Dead load of conc. deck	0.456 in.	1.717 in.
½ Live load and impact	0.430 in.	0.939 in.
Total	1.066 in.	3.642 in.

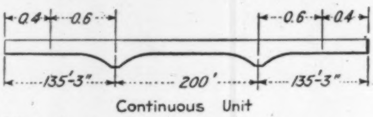


Fig. 4. Calculated deflections on the continuous unit. The actual deflections came close to the estimated figures.

Steel erection

All of the steel for the job, 1,050 tons of copper bearing structural shapes, was shipped by barge from Pittsburgh. Erection started at the north end of the bridge, where a guy derrick with 106-ft. mast and a 95-ft. boom was erected on the north river bank. Part of the north span of the continuous unit was then erected, supported by the concrete pier and a falsework timber bent near the waterline. Next the steelwork over the north river pier was erected, bolted and drift-pinned to the north girders already in place.

The guy derrick was then moved to the south river bank and the south span of the continuous unit was erected in the same manner as the north span. The derrick was next moved to the top of the girders of the south span continuous unit within reach of the center section of the center span. Steel for this last section was lifted from a barge. The largest single piece of steel erected weighed 37 tons and was 103 ft. long.

The dead-load reactions of the steel girders at the main river piers were weighed and adjusted by means of hydraulic jacks, and shim plates were placed before the sway braces were riveted. Steel erection anchors in the piers were burned off and the recesses around the anchors filled with concrete.

Two field coats of aluminum paint were applied to all structural steel after the reinforced-concrete deck had been placed.

The girders were cambered for deadload plus one-half the live load, and the deflections obtained closely checked the calculated deflections. If it had been known that the actual deflections would have been so close to the estimated deflections, a camber for dead-load only would have been used. The top of the handrail was constructed on a straight 1-per cent grade under the full dead load as it would have been unsightly to have cambered the hand-rails between piers.

No cracks have appeared in the concrete deck or sidewalks at points of maximum negative moment. Two transverse expansion or contraction joints were placed in the concrete deck at 6-ft. centers over each of the main river piers, and at intervals of 35 ft. over the remainder of the deck. Vibrations at the center of the main span are hardly noticeable when heavy trucks cross the bridge at average speed.

Roadway lighting

Special attention was given to the lighting of the roadway. The adopted system consists of six standard luminaires and four special luminaires on a 6.6-amp. separate series street lighting circuit. The standard luminaires have medium alabaster rippled glassware and external ornamental ribs; special luminaires, 5 ft. high, located at the ends of the bridge, are of cast bronze with medium density diffusing glass panels (Fig. 2). One 6,000-lumen lamp is used in each standard luminaire and two 6,000-lumen lamps are used in the special fixtures. The luminaires are of decorative design and are pleasing in appearance both day and night. Ornamental fluted steel shafts support the lights 16 ft. above the sidewalk.

Sodium lighting was considered, but because of the relatively short length of structure and because of incandescent lighting used on the approaches, incandescent lights were used throughout.

Navigation lights consist of two 360-deg. green mid-channel span lamps, and each of the main river piers is marked with two 180-deg. red pier lamps. The units, equipped with 100-watt, 110-volt lamps, are controlled by a time clock.

The substructure was built by the Sandy Hites Co., Kansas City, Mo., at a contract cost of $174,000. Steel superstructure was fabricated and erected by the Bethlehem Steel Co. at a cost of $158,000. Total cost of the bridge is about $12 per sq.ft. of roadway.

The plans were prepared by the bridge department of the Kentucky department of highways. Robert Humphreys is commissioner of highways; Thomas H. Cutler, state highway engineer; G. L. Logan, director of construction; H. R. Creal, bridge engineer; W. W. Pardon, district engineer; and H. E. Rudy, resident engineer. Mack Galbreath, senior highway engineer in Kentucky, represented the Federal Roads Administration on the project.

Drought Has Not Changed TVA Water Power Estimates

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Contents in Brief—The effect of the current drought on the flow of the Tennessee River is outlined and comparisons with previous dry years are given diagrammatically. This information was furnished by Mr. Parker at the request of the editors to help the readers of this journal to evaluate widespread report of the serious effect of the drought on the water-power resources of the TVA.

The present drought has not yet become so severe as to cause revision of our estimates of available system power as based upon past records. The draw-down of Norris Reservoir, which began the middle of August to supplement deficient natural streamflow downstream, has followed very closely the plan for normal operation of the reservoir. The elevation of the reservoir throughout the draw-down period this fall has been considerably higher than would be anticipated for the usual type of dry year which begins earlier in the season. At the present time the lowering of the reservoir is still proceeding according to schedule, the elevation being about 950 on this date, which is approximately the elevation planned long in advance.

How much lower the reservoir will be drawn down obviously depends on the amount of rainfall during the next few weeks. Rainfall may be expected to increase, and the flood season begin between now and Jan. 1, as indicated by a long period of record.

Fig. 1 shows by weeks the estimated flow at Florence prior to any regulation from the authority's projects during three years (1904, 1925 and 1933) having critically dry periods with respect to power production, as compared with 1939 (to Dec. 2) after revision to exclude the effect of regulation of the river through TVA projects upstream.

Fig. 2 shows for the current year the estimated flow at Pickwick Landing prior to TVA regulation as compared with that after regulation by Norris and main-river reservoirs. About 80 per cent of the benefit is due to Norris. Also shown is the possible effect of the Hiwassee releases, had that project been in operation during the current year. The beneficial effect of other TVA reservoirs

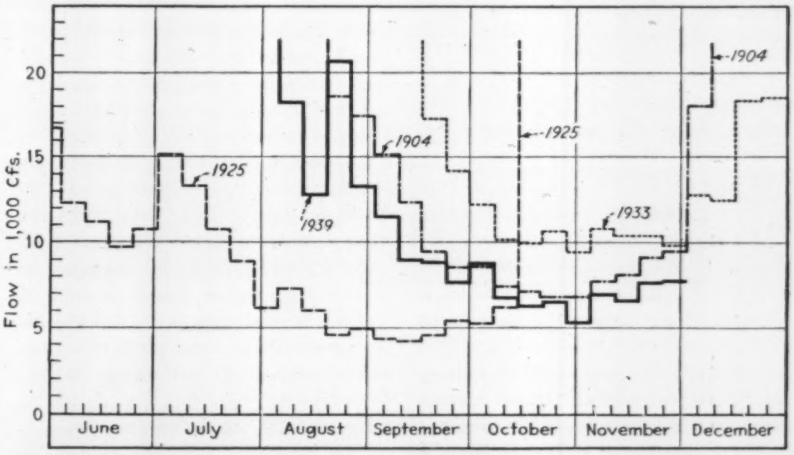

Fig. 1. **Flow of the Tennessee River at Florence, Ala. (Muscle Shoals) during dry years. Years 1904 to 1933 do not include effect of regulation by reservoirs built subsequent to 1933.**

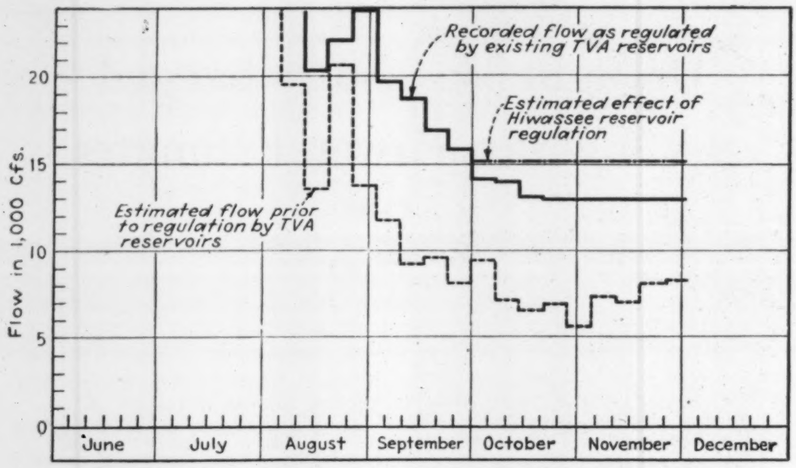

Fig. 2. Effect of TVA reservoirs on the flow of the Tennessee River at Pickwick Landing (lowest of completed projects). Reservoirs now in operation are Norris, Blue Ridge, Ocoee No. 1, Guntersville, Wheeler and Pickwick Landing.

proposed and under construction is not shown.

With respect to operations of the Aluminum Company of America, draft on the main storage reservoir at Santeetlah, which has a capacity of 131,000 acre-ft., began about June 15. By the middle of November storage was depleted to 35,000 acre-ft. The reservoirs at Cheoah and Calderwood have negligible storage. These plants are now practically operating on the natural flow of the streams on which they are located, with output reduced accordingly.

The authority sees no reason as yet to lower its previous estimates of available power and energy on account of the current drought. On Dec. 1 there was remaining available in Norris Reservoir a usable content of about 490,000 acre-ft. Even without any inflow to Norris, the present release of about 5,500 cfs can be maintained for about one and one-half months.

The normal late winter and spring runoff of the Norris Reservoir is ample to refill the reservoir, even if the storage is depleted to a substantially lower level than now exists.

Men Behind Filtration in Chicago

ARTHUR E. GORMAN
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***Contents in Brief**—Many engineers had a hand in bringing water filtration in Chicago to the stage of actual construction. In an article describing the first filtration plant published in these pages recently only the names of those in charge of the current work were listed. In this article the author turns back the pages of history to tell briefly what others did in the past to make the present work possible.*

CHICAGO'S South District Filtration Plant was described by Loran D. Gayton in the Nov. 23 issue of *ENR*, p. 682. The project now in the construction stage was brought to fruition only after several decades of struggle by civic officials and loyal engineers in the public service whose contributions in addition to those credited in Mr. Gayton's article are worthy of record as this first major unit in a new era of Chicago waterworks is brought to the attention of the engineering profession.

The writer recalls vividly the determination with which the late John Ericson, then city engineer, resolved to fight for filtration of the water supply of Chicago after he had been shown that the 1923-24 typhoid epidemic was undoubtedly water-borne. Mr. Ericson was well aware of the fact that economically filtration without metering was not practical. Although he knew that metering was an unpopular subject politically, he fought for it up to the time of his death in April, 1927, even when the odds were seemingly unsurmountable.

In June, 1932, A. A. Sprague, in his second term as Commissioner of Public Works, carrying forward his previous policy regarding metering, recommended an ordinance calling for universal metering, but his efforts were without immediate results.

The late Myron B. Reynolds, city engineer, after a study of the water supply and quality problem, based largely on reports by J. B. Eddy, engineer of water pipe extension and others from the Division of Water Purification, on July 14, 1932, wrote Col. Sprague as follows:

> "Chicago is very much in need of important improvements in its waterworks system, all of which would be self-liquidating as a result of economies to be effected or extra revenues to be earned. They would increase our service to consumers, providing better protection and most important, better protection to the public health, as our water supply is now exposed at times to serious pollution."

He pointed out that RFC loans of $50,000,000 might be obtained for the needed projects covering a ten-year period 1932-41.

On Oct. 21, 1933, in transmitting a report prepared in the Division of Water Purification entitled "Summary Report on Metering and Filtration Projects for the South District" to Col. Sprague's successor, Oscar E. Hewitt, Mr. Reynolds restated his views and added that a substantial increase in the water rate was imminent unless water wastage was stopped because of the large capital expenditures otherwise needed.

The commissioner recommended to the city council that prompt steps be taken to authorize a PWA application for a federal loan and grant.

Much credit is due Mayor Edward J. Kelly and Mr. Hewitt for their support of the project both in city council and before PWA, also in sponsoring the necessary enabling state legislation, passed in July, 1935, by which the city was permitted to issue up to $63,000,000 additional water revenue bonds to finance waterworks improvements and by which the Chicago Park District was given authority to permit the construction of the plant on the lake front and the driving of tunnels under park property. Further, the city has enjoyed the fullest cooperation of officials of the Chicago Park District, the Chicago Plan Commission, the state Division of Waterways, the regional PWA and the U. S. Engineer Office in Chicago.

Six different PWA applications were made for financial aid on this project between 1933 and 1938.

In the writer's opinion too much credit cannot be given to the late Alfred H. Marshall, filtration designing engineer, and the six engineers who were assigned to work under him in the Water Purification Division for the seven-year period 1931 to 1938. During this time the preliminary layouts and cost estimates of the South District Filtration Project at various lake front and inland sites were made, water consumption characteristics were studied, and financial questions investigated. These studies served as the basis for the various PWA applications which culminated in the grant of $5,415,750 offered and accepted Aug. 3, 1938. The six engineers associated with Mr. Marshall and assigned from the Division of Water Works Design were: Maurice A. Drubeck, John J. O'Connor, C. Martin Riedel, Ralph L. Sanders, Frank J. Skall and John C. Sutphen.

Mr. Marshall was first employed by the city of Chicago in August, 1922. With L. B. Bolger he was actively engaged in special studies of filtration and in the preparation of the 1924 and 1925 reports referred to by Mr. Gayton in his article. He was in immediate charge of the design of the Chicago Experimental Plant, developed in accordance with the ideas of John R. Baylis, physical chemist, and prepared in sketch form by the late Carl Speer, junior assistant sanitary engineer, of the Division of Water Purification. These plans were prepared in the Division of Water Works Design while Mr. Gayton was in charge of the division, Mr. Ericson was city engineer and Col. Sprague, commissioner of Public Works.

In 1929 and 1930 when plans for a 576-mgd filtration plant for the South District were prepared in the Division of Water Works Design, based on service to consumers under a partially metered system, Mr. Marshall was in immediate charge of the design staff assigned to this work. A comprehensive set of plans was prepared based on 144-mgd units, four of which were included in the original plant.

The plans indicate that the following engineers were associated with Mr. Marshall on this project: F. B. Ayers, A. A. Duignan, J. Emerick, W. C. Erickson, P. H. Peterman, C. Martin Riedel, B. I. Shoelson, H. Sussman, John C. Sutphen and N. Ulfsby.

In July, 1931, when the policy of filtration design was shifted to a completely metered system, and this work and related studies were assigned to the Division of Water Purification, Mr. Marshall continued as head of the design. His ability was largely responsible for the general layout of the plant and the lake front park developments now being built.

Mr. Baylis has been in charge of Chicago's Experimental Filtration Plant since it was first opened in April, 1928. Much credit is due him for the research work on the chemical treatment of Lake Michigan water preliminary to filtration, for studies of various filtering media and filtration rates and for his notable work on activated carbon, filter washing and the use of silicates in aiding coagulation of water. Associated with Mr. Baylis in the technical problems were Oscar Gullans, senior chemist, Herbert F. Hudson, Jr., junior sanitary engineer, all of the Division of Water Purification.

Two State Bulletins Stress Importance of Records

The importance of keeping operating records of water and sewage treatment plants, and similar plants, is not always realized by the men who keep the records, especially in the case of plants of the smaller class. But this importance of records is stressed in recent bulletins issued by the public-health departments of two widely separated states, Georgia and Illinois. Its influence is exerted in two directions: First, the relation of the records to efficient control of plant operation; and, second, their relation to the knowledge and experience of the operator. Thus, the Georgia bulletin on water treatment methods points out that proper record keeping is educational and increases the value of the operator. It also points out the potential value of good records if the quality of the water should be called in question in the case of local complaints or epidemics. In the Illinois bulletin on the 1939 swimming-pool conference, a paper by J. K. Monteith shows that records indicate the efficiency and safety of operation, the variations in attendance (for seasonal or other reasons), and the cost of operation in relation to public benefit. Records of the amounts of chemicals used, and of chemical and bacteriological tests, are highly important in relation to safe operation of pools. And, as in the Georgia report, reference is made to the value of well kept records in case of accidents leading to legal controversies. Furthermore, the operator himself should realize that the keeping of records is something more than the routine jotting down of figures and statistics. The Georgia report, in particular, states that the operator who keeps good records usually keeps up with progress in water purification.

Power From Sludge Gas at Albuquerque

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***Contents in Brief*—By-product gas from sludge digestion will produce power for the operation of New Mexico's newest disposal plant. The treatment processes include the use of chemical precipitation, trickling filters and two-stage digestion.**

CHEMICAL PRECIPITATION and trickling filter treatment processes combined with facilities for two-stage sludge digestion are employed in the new sewage disposal plant for Albuquerque, New Mexico. By-product gas from the digesters will be used to operate a 150-hp. engine connected with a generator for power production. Serving a present population of 35,000, the plant has a designed capacity of 5 mgd, sufficient to take care of the wastes from 50,000 people.

These new facilities supplant an old sewage disposal system which consisted of settling tanks, open digestion tanks and sludge drying beds.

The flow diagram (Fig. 1) indicates the general layout of the plant and the treatment processes. Sewage is brought through screens, passes through a measuring flume, and is discharged into a wet well for the pumps. Here the chemicals are added and the sewage is then pumped into the mixing or flocculating basin from which it flows by gravity into the settling tank or clarifier. It is then distributed to the trickling filters from which it discharges into the Rio Grande.

Sludge from the clarifier is pumped into a two-stage digestion unit and after being processed it is discharged by gravity to drying beds. Scum from the clarifier is also pumped into the digesters. Overflow liquor from the secondary digester is returned to the wet well and passes through the plant again. Gas is stored in a floating cover on the secondary digester and is piped to the control building. Here the gas is used for power purposes, in the laboratory, or passed to a waste gas burner.

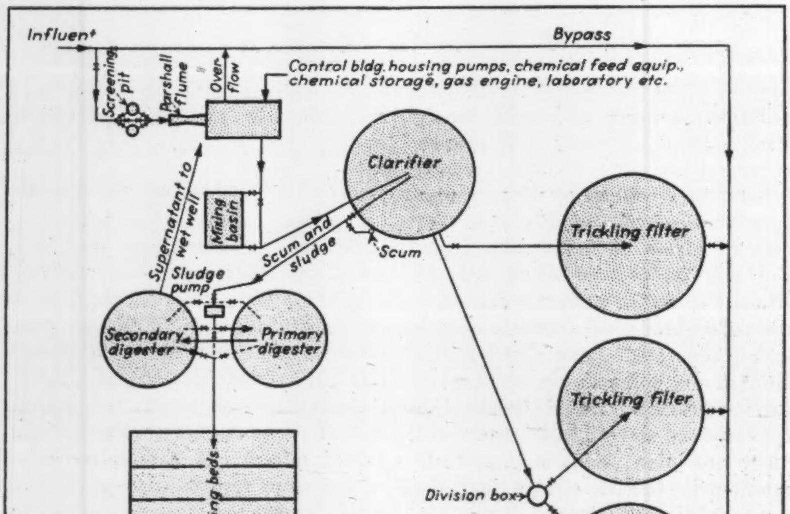


Fig. 1. Flow diagram and general layout of the disposal plant structures.

Installed in the screening pit are two 25-in.-diameter revolving cutting screens of the comminutor type. Provision is also made for the use of a hand-cleaned bar screen in the event of power failure. Between the screening pit and the wet well is a concrete Parshall flume, and in the laboratory is a flow meter actuated from this flume.

Sewage discharges from the Parshall flume into the wet well. On the roof of the wet well are mounted the chemical feed machines, one chlorinator, and two dry-feed machines designed for feeding lime and chlorinated copperas or other coagulants. The coagulant is introduced at a point near the pump suctions so that the chemicals receive a quick mix in going through the pumps. Two automatic float-controlled 2,500-gpm centrifugal sewage pumps are provided, and for emergency use there is a 4,500-gpm manually controlled pump which was moved from the old plant.

Paddles aid flocculation

The flocculating basin, equipped with three rows of revolving paddles, is designed for 45 minutes' detention on the design flow. From here the sewage goes to the clarifier which is a center-feed circular tank equipped with a sludge-removing and scum-skimming mechanism and which has a capacity of two hours' flow at the design rate. The effluent discharges directly into the rotary reaction-type distributors on the trickling filters.

The clarifier weir is so arranged by means of baffles in the effluent trough that under normal conditions one-third of the effluent goes into the east filter and two-thirds passes to a division box where it is divided between the two west filters. Provision is also made so that one-half of the flow can be diverted into the east filter in case one of the other two is out of service, or all of the effluent may be directed to the two west filters should the east one be out of service. No dosing siphons are employed.

The trickling filters are each 160 ft. in diameter with a 6-ft. bed of crushed gravel. Underdrains are slotted vitrified tile blocks with integral drainage channels. A sluice gate is provided on the discharge from each bed so that the beds may be flooded if desired. Open manholes are provided on each end of the effluent channels for inspection purposes and to assist in air circulation.

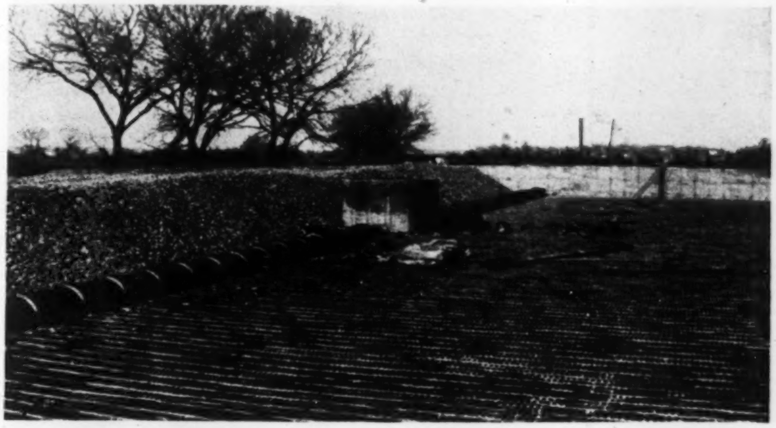


Fig. 3. **Trickling filter construction showing the vitrified tile underdrain system over which there is a 6-ft. bed of crushed gravel.**

Digestion arrangements

Sludge digestion takes place in a two-stage unit which comprises two tanks of 50,000-cu.ft. capacity each. The primary tank is covered with a fixed steel dome and is equipped with two stirring and heating units. The heat exchangers are made of 2-in. wrought iron pipes which are placed in banks close to the stirring mechanisms. Heat is supplied from the jacket water of the gas engine. The secondary tank is equipped with a floating steel gas holder cover which has a capacity of 20,000 cu.ft. on a lift of 8.5 ft. Gas is stored under a pressure of 6 in. of water developed by a concrete ballast ring attached to the lowest shell of the gas holder. No stirring or heating mechanism is used in the secondary digester.

Between the two tanks a sludge pump and valve house is built. The sludge pump is of the plunger type and is controlled by an automatic time switch. Piping and valves are so arranged that raw sludge may be pumped into either tank, or sludge may be pumped from either tank to the drying beds. Under normal operations sludge will be pumped at predetermined intervals of time from the clarifier into the primary tank. Sludge displaced from the primary will flow into the secondary and overflow liquor from the secondary will be returned to the wet well.

Gas is piped from the secondary digester to the control building through a 4-in. pipe. Here it passes through drip tanks, meters, pressure regulators, valves, and flame traps and is used in a 150-hp gas engine, in the laboratory, and for general and hot water heating.

Gas engine installation

The power unit is a 5-cylinder, 4-cycle gas engine, direct-connected to a generator. The engine has a nominal sea-level rating of 150-hp when operating at 514 rpm. The generator is a 480-volt, 3-phase, 60-cycle machine with direct-connected exciter and has a rated capacity of 110 kva. The engine cooling water system consists of heat exchangers in the flocculating basin and in the primary digester. It is planned to regulate the heat in the primary digester by manual control of valves in the sludge pump house; closing of these valves to limit the amount of water passing through the primary digester will cause an automatic back-pressure valve located in the line leading to the heat exchanger in the flocculating basin to open and by-pass part or all of the water through pipes in the flocculating basin. Wrought iron is used for all piping in the cooling water system that is immersed in sewage.

Switching equipment is so arranged that (1) the plant may operate from its own power plant or (2) it may operate from the public utility system or (3) the plant power unit may be operated in parallel with the public utility system.

Construction cost of the entire plant, including grading of grounds, fencing, and hauling in of topsoil, was about $233,500. This cost was financed through a city bond issue and a PWA grant. The general contractor on the job was Bradbury and Marchant of Albuquerque. Resident engineer inspectors for the Public Works Administration were R. B. Gaines, who was succeeded by Andrew O'Rourke, Jr. The plant was designed and construction supervised by Holway and Neuffer, consulting engineers, for whom Paul C. Thompson served as resident engineer.

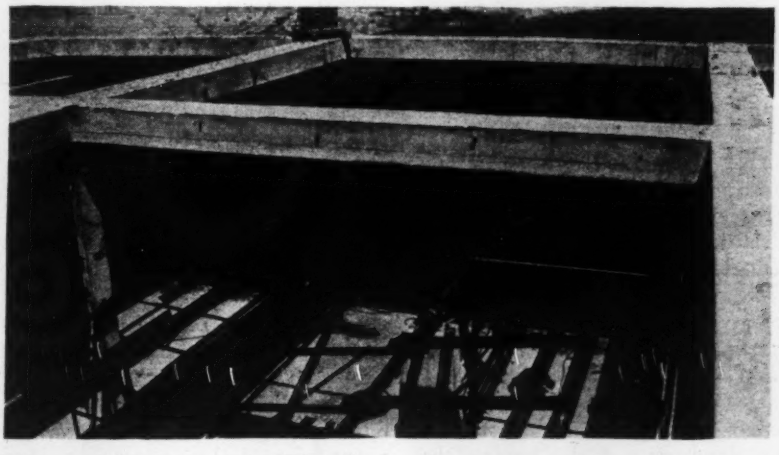
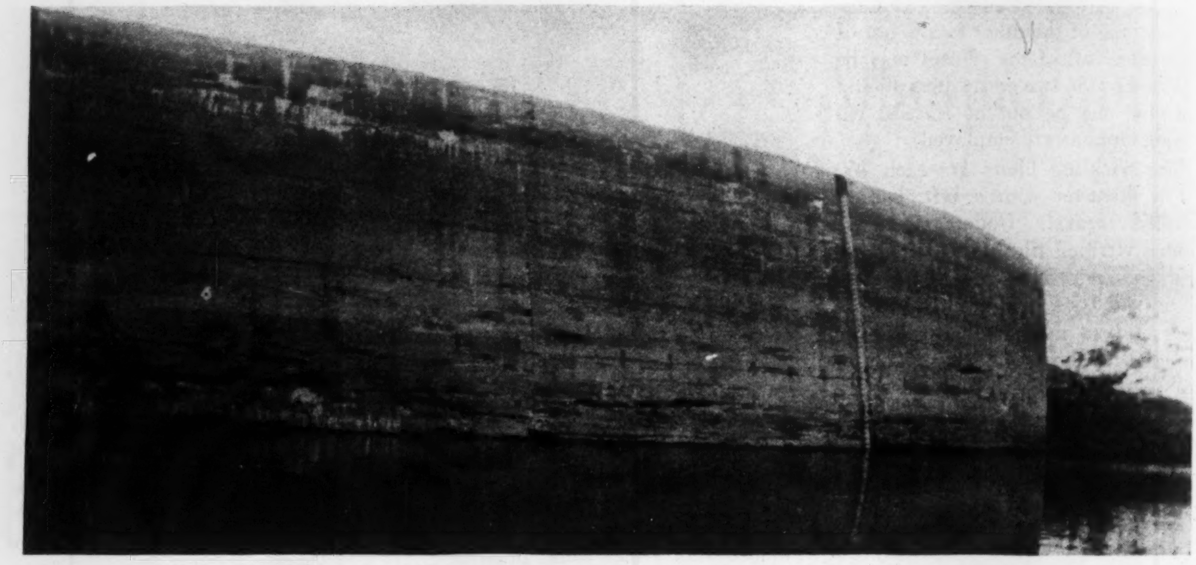


Fig. 2. **Mixing basin equipped with paddle wheel-type agitator to assist flocculation.**



TOP SEVENTY FEET OF THE UPSTREAM FACE OF SPAULDING DAM BEFORE REPAIR STARTED.

Repairing Damaged Concrete On the Face of Spaulding Dam

***Contents in Brief**—To stop seepage through upper portions of Spaulding Dam, some 26,000 sq.ft. (about 25 per cent) of the upstream face was given a shotcrete coating, for the most part 2 to 4 in. thick, firmly anchored in place with steel dowels imbedded in the old concrete.*

SPAULDING DAM, on the hydro-electric system of the Pacific Gas and Electric Co. in California, is in a location where freezing temperatures ordinarily obtain for three to four months each winter. In recent years frost action on portions of the exposed upstream face caused disintegration of some of the surface concrete with occasional pockets of considerable depth. Seepage that appeared on the downstream face was ascribed to leakage through horizontal construction joints and vertical contraction joints.

Recent periods of low runoff afforded opportunity to work on the upstream face while the reservoir was well drawn down sufficiently early in the fall to permit of doing the work before the start of cold weather. The repairs recently completed include the chipping away of deteriorated concrete on an area of some 26,000 sq.ft. and replacing this with impervious shotcrete. The work has been successful in stopping practically all seepage through the dam. A description of additions to the height of Spaulding Dam, including a section drawing, was published in *ENR* Nov. 25, 1920, p. 1,020.

Water stored in this reservoir and in others of the company's system where somewhat the same effects in lesser degree have been observed, is of the extremely pure quality produced by melting snow. Hence it has an affinity for any material with even a slight degree of solubility. This, plus the severe frost action on concrete put in as long ago as 1913 when technique in placement, particularly at horizontal construction joints, was below present-day standards, combined to cause the damage. Practically no deterioration was observed in the top 15 ft. of the structure which was added in 1919, due mainly to better concrete construction standards and also because the top area is not subjected to fluctuating water levels during periods of extremely low temperature.

The 26,000 sq.ft. of shotcrete placed represents 25 per cent of the total upstream face of the dam and was located in a zone between 15 and 86 ft. below the crest. (The dam is 225 ft. high.) About 95 per cent of the area treated was resurfaced to a depth of 2 to 4 in.; the remaining 5 per cent consisted of small and scattered areas of greater depth. Very little damage was observed and no repair work is considered necessary below the 86-ft. level. The concrete on the downstream face of the dam is in good condition and has not required any repairs.

The crest of the dam was constructed level but slight imperfections permitted accumulation of water which with frost resulted in surface scaling. This is being corrected by the removal of injured concrete and replacement thereof by a new and sloping deck of shotcrete. Also an 18-in. reinforced shotcrete coping wall is being added along the upstream edge of the crest to prevent waves from splashing water on to the crest of the dam.

Removal of deteriorated concrete on the upstream face was carried on from barges floating on the reservoir whose level was lowered as the work progressed. Pneumatic gads were used for breaking out the heavier parts and chipping guns were used for dressing up. In a few places, particularly along the vertical contraction joints which are on about 80-ft. centers, there were occasional spots where the disintegration had penetrated to a maximum depth of 3 or 4 ft. However, these were for small areas only and constituted pockets in which special repair methods were used.

Feather edges and wedge-shaped cavities were avoided in the areas and in the pockets chipped out, and every endeavor was made to square up the spaces into which new material was to be placed. For the deeper pockets a 4 to 6 per cent (by weight) admixture of a powdered iron compound was used with the cement to counteract shrinkage as much as possible.

Where the thickness of the new layer was to be 8 in. or less the reinforcing consisted of 4x4-in. mesh of No. 8 galvanized wire. A single layer was used in thicknesses up to 4 in. and two layers for 4 to 8-in. thicknesses. The mesh was held in place by 3/8-in. Rawl drives, a form of expansion bolt which can be used in drilled holes no larger than the diameter of the projecting rod. These were driven in to depths such that the heads projected about one-half the thickness of the shotcrete layer to be applied, thus making it possible to anchor the wire mesh at approximately the middle of the layer of new material. The spacing of these anchor bolts varied from 1½ to 3 ft., according to conditions, about 11,000 being required for the job.

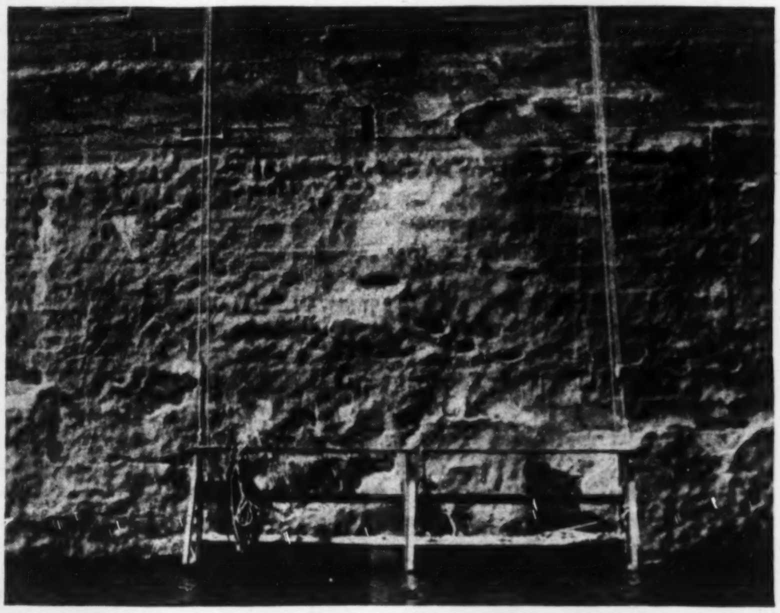
In pockets where deterioration depth exceeded 8 in., after excavating to solid concrete and squaring up the corners, holes normal to the exposed surface were drilled for 5/8 or 3/4-in. steel dowels (40 diameters deep) which were grouted in. In all cases projecting ends were hooked to support a grillage of 5/8 and 3/4-in. reinforcing bars placed on 12-in. centers in both directions.

Placing the shotcrete

Two chipping crews and one shotcrete crew worked simultaneously, usually with the shotcrete crew at higher levels. The crews were strung along the face of the dam with sufficient separation to avoid interference. Shotcrete was applied from swinging scaffolds lowered from counterweighted stiff-leg derricks that traveled on a 36-in.-gage track along the dam crest. The booms projected out far enough to lower the scaffolds effectively despite the slight slope on the upstream face. Air and water pipes had been laid across the crest and sand and cement were mixed, dry, in a concrete mixer at the camp just above the crest level. The mixer discharged dry batches through a chute to a loading bin just above the crest where delivery was made to 1-cu.yd. cars taken out on the dam by a gasoline locomotive. The shotcrete gun was spotted on the dam crest above the working platforms so that hose to delivery nozzles were of minimum length and dropped almost vertically to the point of application.

The shotcrete consisted of a 1-to-4 mix using a well-graded sand ranging up to 1/4-in. size. Puzzolanic cement was used until cold weather when a switch was made to quick-hardening cement. Both varieties have the advantage of producing a sticky mix that decreases rebound. When each shotcrete application had been finished and had been allowed to set for at least 12 hr., a 1-to-5 solution of sodium silicate and water was put on with a spray gun. The application was liberal enough to flush the surface and fulfill the functions of (a) combining with any liberated lime to render it insoluble and (b) sealing off the shotcrete surface as an aid in curing.

Repairs on the dam were made by company's own forces under the supervision of O. W. Peterson, engineer of general construction.



Surface prepared for shotcrete in a zone where a large part of the area had deteriorated.

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Municipal Water Losses From 9 to 20 Per Cent

Unmetered water used (or wasted) in cities along the Pacific Coast ranges from 9 to 20 per cent of the total supply delivered, according to statements at roundtable discussions in recent sessions of the A.W.W.A. sectional meeting at San Francisco.

Losses in this classification include all leakage, water used for fighting fires, flushing sewers and streets, sprinkling in parks and, in general, all water delivered to the distribution system but not accounted for by meter readings.

Cities in which leak elimination has been carried to the highest degree showed notably low total losses. The lowest total loss of 9 per cent was reported for the East Bay Municipal Utility District (Oakland, Calif.) where highly efficient devices for determining leaks have been developed and used for a period of years.

The City's Sewage Goes to Sea–III

N. A. Bowers
Pacific Coast Editor, Engineering News-Record

Contents in Brief—This final installment in a series summarizing experiences with subaqueous outfall sewers discusses operation and maintenance methods; also included is a table of costs and characteristics of major installations. The first installment (ENR, Nov. 23, p. 689) dealt with functions of types of outfall sewers and the second (ENR, Dec. 7, p. 764 was devoted to design and construction features.

THE HIGH DEGREE of dilution and dispersion afforded by tidal currents has made ocean outfalls particularly attractive to cities near the sea. Unfortunately, there has been a tendency to assume that ocean disposal, once an outfall has been built, will function indefinitely, free from operating costs. As experience has accumulated, these attractive objectives have been found to be less easily obtained than was assumed: dilution of the sewage, strictly speaking, results only when solids have been dissolved or removed and the ceaseless surge and scour of waves and tides may combine with any minor weaknesses in the outfall line to develop difficulties leading to expensive repairs. In the following are cited some typical operating problems and conclusions which designers have based thereon.

Because joints have been such a frequent cause of trouble many designers have endeavored to analyze operating conditions in outfalls with respect to the effect on joints. On this point there is now general agreement that the effect of ocean waves on a submerged outfall is constant (and frequently sudden) variations of pressure head within the pipe. In a penstock these variations would be called "water hammer".

In other words, the head variations at the end of the outfall are superimposed on the velocity of sewage within the line. Resultant pressures at different points along the inside of the pipe may be considerably at variance with pressures due to wave action at corresponding points outside the pipe. Thus, if any joints open slightly from any cause, forces are acting incessantly to produce reversal of pressure and flow through such openings. This trouble is likely to get worse progressively; it is almost certain to cause escape of sewage; it may be accompanied by inflows of sand, and on the whole is generally accepted as one of the most serious causes of outfall damage or complete destruction.

Any concrete-lined approach to an outfall now is usually built where it will be constantly under hydrostatic head. This is because sewage may be highly septic by the time it reaches the outfall and hence a serious menace to unprotected concrete where gases can form to attack the surface. Where no form of pretreatment is employed, a grit chamber on the shore end of an outfall is often recommended, particularly if so located that accumulations can be sluiced out above water level by gravity.

Manholes for inspection

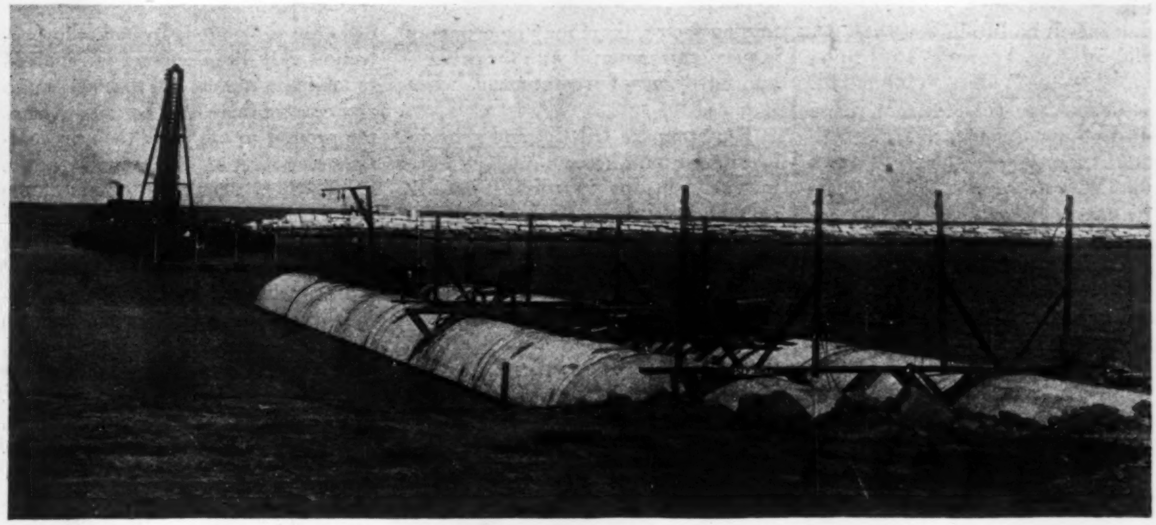
The installation of submerged manholes 300 to 500 ft. apart in subaqueous outfalls has come to be considered good design because it permits convenient inspection of the inside of the line by divers. Where manholes have not been provided, maintenance crews have sometimes had to blast holes in the top of the pipe to provide access.

In one long outfall damaged by earthquake, manhole covers were left off in process of inspection and repair and enough sand entered through the manholes, as the result of wave action, to require removal by sand pumps before the line could function.

Another example of sand clogging occurred in the Los Angeles outfall sewer at Hyperion. Back pressure developed in this line and in an endeavor to decrease the amount of sewage escaping nearer shore, holes were made in the top of the pipe at intervals near the outer end. Soundings through these holes showed sand about 3 ft. deep near the open end of the line, decreasing to none several hundred feet inshore. The conclusion was that considerable sand had entered through the open end, more had come in through leaky joints from the sand backfill, and some had come through the screening plant. Reconstruction of the terminal end of this outfall was described in *ENR*, May 6, 1937, p. 670.

On a number of ocean outfalls near beaches used for recreational purposes, fine screens have been used to remove solids before sewage is discharged. This form of treatment in several instances has been unsatisfactory because of grease and oil in the sewage. As these ingredients pass through the screens they combine with fine organic matter and roll up into balls in the outfall. Partly as the result of this operating difficulty in recent years there has been a trend away from screening and toward sedimentation as pretreatment for ocean disposal.

With an increasing number of garages tributary to sewers the grease problem has become more of a nuisance in choking sewers, particularly interceptors and outfalls. An effluent line of 36-in. spun concrete pipe operating under pressure, recently taken up after ten years of service, was found to be lined throughout its entire length of 3½ mi. with a grease deposit ¾ in. thick on the invert and ¼ in. in the arch. Because this danger of grease deposition introduces a problem in operation and maintenance, designers are emphasizing the importance of skimmers, or some other means of grease removal. The grease problem also puts emphasis on the need to provide access to all parts of the line, whether tunnel or pipe, to avoid undue expense should



Twin outfall sewers each 9 ft. in diameter which were extended 700 ft. into Lake Erie at Cleveland.

operating troubles make it necessary to enter the line.

When construction of an outfall is completed there is much yet to be done to keep it in serviceable condition. It is customary to have the line inspected from time to time by divers to see whether there is settlement and whether the joints remain tight under the strain that movement of any sort imposes upon them. Inspection also will show whether enough sand or grease has accumulated to reduce the capacity and whether cross-currents have undercut the foundation. On one large outfall on the west coast the trench in which the pipe was to be laid was excavated with a grab bucket and was not thereafter leveled with small rock. Resultant irregularities in gradient put such strain on the joints that there were numerous breaks requiring expensive repairs by divers in calking, fitting concrete collars, and pouring new sleeve connections between sections. On this job the contractor spent some $30,000 in work on the joints immediately after completing construction. Later, additional repairs were required; ultimately more than $200,000 was spent on repairing this pipe line without preventing sewage from leaking through the joints.

Constantly submerged metal pipes of types adapted to sea water exposure have given good service in ocean outfalls. In the tidal zone where air and water alternately would have access, the line must be encased in concrete or at least buried.

Cast iron is generally accepted as

TABLE II—STATISTICS AND COST DATA ON SOME TYPICAL SUBAQUEOUS OUTFALL SEWERS

Pipe Dia., inside (inches)	City or District	Year built	Designed capacity (mgd)	Type of joints	Outlet depth (ft.)	Total length from high water (ft.)	Total cost (dollars)	Average cost per foot (dollars)	Type of Pipe			Laid in trench (ft.)	Laid on bottom (ft.)	Supported above bottom
									Cast iron	Concrete	Other types			
6	Sunset Beach, Calif	1936	0.13	Bell and spigot	16	1,300	3,950	3	1,300	......	....	150	1,150	......
8	Capitola San. Dist., Calif	1933	.....	Bolted	18	500	3,166	6	500	......	....	......	500	......
12	San Diego, Calif	1928	2.59	Screwed & welded	19	1,435	22,000	15	......	......	Wrought iron 1,435[1]	175	1,260	......
15	Seabright, N. J	1939	.....	Welded	18	1,000	18,000	18	......	......	Wrought iron	200	800	......
15	(2) Santa Cruz, Calif	1927	.....	Welded	42	2,000	90,000	45	......	......	Wrought iron 2,000[2]	1,000	1,000	......
16	Watsonville, Calif	1926	.....	......	19	1,500	26,726	18	......	......	Wrought iron 1,500	......	1,500	......
17	Ventura, Calif	1927	2.18	Welded	26	1,900	37,000	19	......	......	Copper-bearing steel, 1,900	100	1,800	......
23	Asbury Park	1934	.....	Welded	21	1,055	16,880	16	......	......	Wrought iron	......	......	......
24	Monterey, Calif	1934	.....	Universal (bolted)	50	1,000	15,000	15	1,000	......	....	200	800	......
36	Miami Beach, Fla	1937	25.9	Bolted	40	6,758	600,000	89	6,758	......	....	6,758	......	......
36	(2) Waukegan, (Ill.)	1936	35.28	Bolted	10	365	22,000	60	365	......	....	......	......	365
42	Ashtabula, Ohio	1925	20.16	......	20	3,550	125,000	35	......	3,550	....	3,550	......	......
42	Santa Ana, Calif	1927	13.00	Bell & spigot	40	3,000	300,000	100	3,000	......	....	......	2,300	700
48	Honolulu, T. H	1927	44.64	Bell & spigot	60	2,773	286,281	105	2,773	......	....	1,488	1,285	......
60	Los Angeles County Dist	1937	69.84	Flexible	100	5,000	528,000	94	......	5,600[4]	....	3,100	2,500	......
60	Toronto, Can	1911	60.00	Bolted	19	5,330	134,300	25	......	1,780	3,550 steel	3,100	1,700	530
60–72	Cleveland, O. (West. Dist.)	1916	90.72	Flanged	30	2,600	70,000	27	......	400 (72 in.)	2,200 steel (60 in.)	2,600	......	......
72	Coney Island, N. Y	1935	100.00	Lock joint	20	6,920	380,600	48[3]	......	6,920	....	6,920	......	......
84	Cleveland, O. (East. Dist.)	1918	120.96	......	30	3,200	205,000	64	......	3,200	....	3,200	......	......
84	Boston, (North Met. Dist.)	1895 1917	162.00	Bell & spigot	50	2,022	269,500	132	322	1,700	....	1,882	140	......
108	(2) Cleveland, O. (East. Dist.)	1932	181.44	Bell & spigot	9	700	70,000	100	......	700	....	......	......	700
144 and two 96-in. dispersion pipes 1,500 ft. long.	Passaic Valley (N. J.) Dist	1913 1924	325.00	......	55	25,600	8,443,840	330	......	25,600	....	......	......	......

[1] Wrapped with canvas and asphaltic-base enamel.

[2] With 2-in. of cement on wire mesh with asphalt base enamel coating.

[3] Including $60,600 for outlet chamber and diffuser.

[4] Two pipes at shore end.

having indefinite life in sea water. A special cast iron, known as Meehanite, was used on the White's Point outfall. This metal has a peculiarly dense quality obtained by introducing calcium silicide into the melt to get a more effective distribution of the carbon content, with the result that unlike ordinary cast iron, this product can be readily welded. This makes it possible to have the economy of reinforced concrete pipe barrels (important in very large diameter pipe) plus the advantage of ball and socket joints in cast iron welded to reinforcing bars in the concrete, thus eliminating risk of galvanic jump between two metals. Recent surveys by divers have shown the White's Point pipe to be functioning perfectly.

Wrought iron has been used extensively for the smaller diameter outfalls (up to about 24 in.) with excellent results. A general opinion concerning it among those who build ocean outfalls on the Pacific Coast was expressed by an engineer who recently inspected a line of this pipe he had laid some years previously. "From present indications," he said, "it appears that this will last indefinitely."

Because of the ductility and weldability of wrought iron, it is said that the use of straight welded joints or of sleeve-reinforced joints imparts to the line a strength at the joints considerably greater than that of the pipe itself. In this connection there is a further advantage in the use of reinforcing sleeves in that by varying the length of sleeve employed, the line may be designed for an almost infinite variation in rigidity. The ability of wrought iron to withstand reversals of stress also is a factor of importance when considering hazards from settlement or failure of foundation facilities. Experience along the New Jersey coast, where thirteen wrought iron outfalls are in use, reveals that in only three or four cases was there any bottom preparation (trenches or pile supports) prior to pipe laying.

Copper bearing steel is relatively new but the report of A.S.T.M's. Committee 5 indicates that, submerged, it is not superior to steel in resisting corrosion. Steel pipe, though not generally rated as durable in sea water, has the advantage of relatively lower cost. Moreover, where hazards are so great that the physical life of the line may not be the determining factor, there may be economy in using this material with the deliberate intention of replacement when required.

The Standard Oil Co. and subsidiaries now have some 17 mi. of submarine oil pipe in service, mostly welded, low-carbon steel, 8 to 18 in. in diameter; thicknesses $\frac{1}{3}$ to $\frac{5}{8}$ in. Since the first of these lines was laid ten years ago the company has improved the practice materially, principally in the endeavor to get lines that would resist electrolytic corrosion. This must be considered even when using metals immune to chemical reactions with sea water. An effective aid is the use of an insulated union at the shore end. Still more effective is a coating of dense, asphaltic material (Somastic) plus cathodic protection. In cathodic protection very little current is required to maintain a potential that will cause any current there may be to flow *from* the ground *to* the pipe, thus preventing electrolytic corrosion of the metal. Steel lines thus protected, the Standard Oil Co. states, "are expected to last practically indefinitely, as far as external corrosion is concerned."

In conclusion: few subaqueous outfall sewers of large diameter are free from maintenance and repair costs. The service records of such outfalls show difficulties whose general classification, in what is frequently accepted as the usual order of importance, is (1) failures at joints (2) breaks in the line resultant from failure in the foundation and (3) clogging with sand or grease.

Wall Crack Study Underway

IN AN EFFORT to determine causes of cracks in exterior building walls, the United States Housing Authority, in cooperation with the National Bureau of Standards and the New York City Housing Authority, has begun a program of observation and measurement on a test building at the Bureau of Standards at Washington and on the Queensbridge and Red Hook housing projects at New York. The program is an outgrowth of the studies that followed discovery of serious cracking in a number of the early housing projects. Since these cracks were most pronounced at the roof line, where the concrete slab joined the tile and brick walls, the present study will concentrate attention at that location. Instrument points for strain gages and clinometers have been installed in both walls and roof, particularly at the corners of the buildings, where cracking tendencies have been greatest; and in the test building at Washington thermocouples have also been installed in the roof slab to record temperatures.

Unusual care was taken in the design of the buildings of the Queensbridge project (*ENR*, July 20, 1939, p. 54) to incorporate slab reinforcing and structural wall details that would eliminate cracking, and inquiry last week revealed that absolutely no cracks have appeared although many of the buildings are a year old. On the other hand, the test building at Washington was built to reproduce the arrangement in some of the earlier housing projects where cracks did occur, and although the building is only three months old cracks are already in evidence.

The test building is 50x26 ft. in plan with one row of columns dividing it into transverse spans of about 15 and 11 ft., respectively. One-half of the perimeter of the roof slab is supported directly on the walls, while the other half is carried by a wall beam integral with the slab. No special reinforcing is used in the slab to keep it from curling under shrinkage stresses.

Readings will be taken during the next year, covering a full cycle of temperature and shrinkage changes in the concrete. From the measurements of wall and slab deflections, slab shrinkage, slab curling and relative thermal expansion and contraction of the masonry walls and the concrete slabs, it is hoped that data will be provided which will point to proper design methods for future housing projects and other buildings that utilize similar materials and construction details.

FROM FIELD AND OFFICE

Working problems and time-saving methods . . . Edited by Charles S. Hill

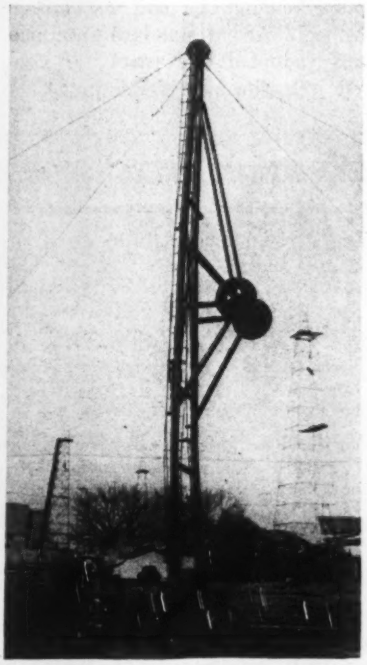
A-Frame for Road Hauls

Elton Sterrett
Longview, Tex.

Between-job transportation of the conventional A-frame involves the use of a truck and trailer, and is only imperfectly solved by temporarily inserting an axle and a pair of wheels somewhere along the frame to provide necessary road support.

As illustrated, one contractor solves the problem and also braces the frame against severe service stresses by welding a series of braces to one side of the frame, the braces converging at a point midway of the 40-ft. frame to take a standard trailer axle at this point.

When the frame is in use, the axle and wheels are merely suspended in mid-air, but when the road is again taken, the wheels support the weight of the frame, the wider or butt end being taken aboard the truck which provides the motive power. The weight of the sheave is supported by the longest of the braces, and the structure is readily handled over any roads which can be negotiated by other trucks and trailers.



The bracing of this A-frame supports the outer end during job shifts, and stiffens the uprights during heavy lifts.

In erecting the frame, the butt is dropped at the designated point, the wheels first being rolled up onto the towing truck to provide additional lift to the top. When thus set, the frame is readily raised to a vertical position with no auxiliary equipment other than a snatch-block to give proper direction to the truck's winch line.

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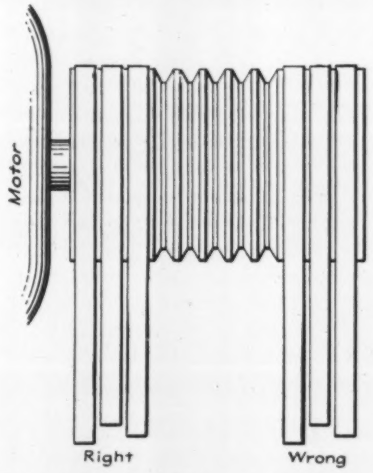
Right Location of Drive Ropes

W. F. Schaphorst
Newark, N. J.

Often V-belt drives are improperly belted as indicated by "wrong" in the accompanying sketch. That is, when the sheave is partially belted with only two or three ropes, the ropes are placed at the end of the sheave, as far away from the motor bearing as possible. The explanation is: it is the easiest place to put the ropes.



Right and wrong belting of rope drives.

The correct way is to place the ropes as close to the motor as possible as indicated by "right" in the sketch. By so doing there will be less bearing pressure owing to the smaller leverage of the ropes. In any belt drive, the greater the distance of the center of belt pull from the center of the bearing, the greater will be the pressure of the shaft against the bearing, and, consequently, the greater will be the friction and loss of efficiency.

CAMERA MEMORANDA

At Hiwassee Dam two dormitory buildings are set at an angle to form a V, the apex of which is closed by a shower and toilet building that serves both. This is a TVA invention.

This also makes clear one of the reasons why double-ply belts are preferable to single-ply: the center of pull of a double-ply belt is closer to the center of the bearing.

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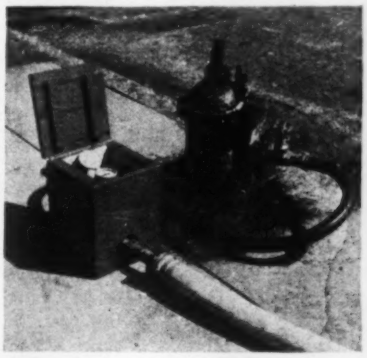
Housing Protects Temporary Meters

Wooden housing is used for temporary water connections installed by the Cranston, R. I., Sewer Commission for construction operations. The substantial wooden box protects the meter from possible damage while it is in use, and also when it is placed in storage. Use of a meter on construction jobs or for other temporary water connections eliminates the possibility of arguments concerning payment for water, and also helps the water department to maintain an accurate record of consumption.



Temporary water meter protected by wooden housing.

A short length of hose fitted with a hand valve and socket connects the meter with the hydrant.

BOOK NOTES AND REVIEWS

The month's additions to the engineer's reading and reference list

Water Plant Operation

PRACTICAL PROCEDURES FOR THE WATERWORKS OPERATOR—State Department of Public Health, Division of Sanitation, Atlanta, Ga. Multigraphed, 47 pp. Limited free distribution.

Prepared as a guide for the efficient operation of water treatment plants, particularly those of the smaller class, this bulletin is an informative handbook of control methods and procedures in making tests. It deals with: (1) chemical laboratory tests such as alkalinity, carbon dioxide, hardness, and residual chlorine; (2) bacteriological laboratory tests, their nature and application, and (3) operation and care of chemical feeders, hypochlorinators and chlorinators. A list of up-to-date books and pamphlets on water treatment is also included.

Designing for Continuity

AUTOMATIC DESIGN OF CONTINUOUS FRAMES IN STEEL AND REINFORCED CONCRETE—By L. E. Grinter. Published by The Macmillan Co., New York. 141 pp. Price $3.

It is seldom that a book on structural engineering is concerned with a single design method, but those few that have followed this pattern are intensely practical. This book is no exception in this respect and, in addition, it presents a method that will be new to most readers, since the author's only previous discussions of it have been in articles in *Engineering News-Record* in March and in *Civil Engineering* in June of this year. Stemming from the Hardy Cross method of moment distribution, the automatic design method, which has been tested over a six-year period by the author, goes a step farther and balances section moduli (instead of moments) thus giving the required size of member immediately. The method, it is to be noted, is one of design and not of analysis; and, as background for proper understanding, the first two chapters discuss the philosophy of the automatic method in comparison with the so-called classical methods such as slope deflection and describe the modern methods of analysis that have been presented by Hardy Cross, Clyde T. Morris, Henry Spurr, L. E. Grinter, W. M. Wilson and G. H. Maney, among others.

With its rather complete coverage of modern concepts of designing for continuity and its presentation of a design method planned for ease and accuracy, the book will be found both useful and stimulating.

Seven Place Tables

NATURAL TRIGONOMETRIC FUNCTIONS with increment to seconds. Prepared by Charles E. Sharp, Jr., published by Marchant Calculating Machine Co., 1465 Powell Street, Oakland, Calif. Price 25c.

Calculations involving trigonometric functions, when made on calculating machines, permit the use of functions in the natural form as distinct from the logarithmic form. A lack of such tables having the degree of accuracy generally found in logarithmic tables led to the publication of this set of seven place natural sines, cosines, tangents and co-tangents to minutes with direct reading increment to seconds. The increments to seconds follow curvilinear interpolation and have been checked to third differences. The tables are printed by the planograph process on sheets punched for 8½ x 11-in. looseleaf binder and comprise 31 pages including explanatory text.

MISCELLANEOUS NOTES ON BOOKLETS AND REPRINTS

SWIMMING POOLS AND THEIR OPERATION—a complete report of the 1939 Illinois Swimming Pool Conference—is the subject of a bulletin issued by the Division of Sanitary Engineering of the State Department of Public Health, Springfield, Ill.

WROUGHT IRON, Its Manufacture and the Characteristics in Application is the subject of a booklet published by the A. M. Byers Co., Pittsburgh, Pa. (Price, $1). The section on specifications and durability testing contains an important listing of various specifications for wrought iron and products made of wrought iron, prepared by numerous associations and government agencies.

A CONCISE HISTORY of the water supply of New York City has been prepared in pamphlet form by Joseph Goodman, Commissioner, Department of Water Supply, Gas & Electricity (2358 Municipal Building, New York).

THE ASPHALT INSTITUTE has issued three pamphlets containing papers presented at the twelfth National Asphalt Conference in Los Angeles last February. Research Series No. 5 contains the papers on materials; Construction Series No. 49 contains the papers on design and construction, and Construction Series No. 50 contains the papers on equipment. (The Asphalt Institute, 801 Second Ave., New York).

CONCRETE PIPE FOR IRRIGATION AND DRAINAGE is the subject of an illustrated booklet put out by the American Concrete Pipe Association, 33 West Grand Ave., Chicago. Points covered include design factors, especially flow charts and diagrams; irrigation appliances such as gates, hydrants, orchard valves and meters; and construction pointers, such as joints, foundations and backfilling. The rigid ASTM standard specifications (adopted this year) for concrete irrigation pipe are included.

NEW ENGINEERING BOOKS

LATTICE GIRDER BRIDGE—By H. P. Philpot, Benares, India. 223 pp. Published by Longmans, Green & Co., London and New York. Price $2.60.

SURVEYING AND BOUNDARIES—By Frank Emerson Clark. Second Edition. 896 pp. Published by The Bobbs-Merrill Co., Indianapolis. Price $6.

ALL ABOUT HOUSES—By Groff Conklin. 194 pp. Published by Julian Messner, Inc., 8 West 40th St., New York City. Price $2.

BUILDING THE CANADIAN WEST—By James B. Hedges. 422 pp. Published by The Macmillan Co., New York and London. Price $4.

SOIL CONSERVATION—By Hugh Hammond Bennett. 993 pp. Published by McGraw-Hill Book Co., New York and London. Price $6.

(*Continued on p. 76*)

300 FEET OF TRU-LAY PREFORMED

sells 20,000 more! . . .

● A contractor once bought a big supply of non-preformed wire rope because of the then rising market. In spite of this the foreman dogged the heels of the superintendent, insisting that he be given TRU-LAY Preformed. Finally, the "sup" ordered a 300-foot length of TRU-LAY "just to keep that foreman quiet."

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CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

EAST RIVER DRIVE NEW YORK

OWNER: Department of Borough Works, President, Manhattan Borough, New York, N. Y. E. Rizac, engineer.

PROJECT: Construction of roadway, curbs, sidewalks, promenade and appurtenant work to connect portion of East River Drive now under construction through Carl Shurz Park with existing pavement at 93rd Street. Located on East River Drive from East 90th St. to East 93rd St. Involves relaying hexagonal block pavement; removing existing roadway pavement; drainage facilities; curbs; sidewalks; granite block paving; lighting system; fire and police facilities; and automatic traffic recording system.

CONDITIONS: Contractor will not have exclusive storage space at location of work as other contractors are in process of constructing works in vicinity. Highway, rail and water transportation facilities available. Fire alarm posts, granite curbing (salvaged), 6-ft. fence (used), and time switches are to be furnished by city. Project to be completed by May 22, 1940. Wage rates are: skilled, $1.15 to $2.12½ per hr.; semi-skilled, $1.00 to $1.50; and common, 87½c. to $1.50 per hr.

BIDS: Ten bids were received October 31, 1939, ranging from $104,278 to $165,430.

LOW BIDDERS:

1. Madden & Lane, Long Island City, N. Y. (contract)	$104,278
2. Barry Cont'g. Co., Laurelton, N. Y.	104,854
3. Frank Mascali & Son, New York, N. Y.	105,098

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Excavating and grading	5,500 c. y.	$0.50	$0.35	$1.00
2. Sewer excavation	300 c. y.	1.00	1.00	1.00
3. Inlets, complete	10 ea.	80.00	125.00	150.00
4. Basins, new castings	2 ea.	110.00	200.00	150.00
5. Basins, salvaged castings	1 ea.	100.00	150.00	100.00
6. 12-in. vitr. pipe drains	550 l. f.	1.70	1.50	2.50
7. Fire alarm post and conduit	L. S.	300.00	331.00	500.00
8. Cl. B conc. for police facilities	10 c. y.	13.00	25.00	20.00
9. 2-in. galv. copper brg. steel pipe	540 l. f.	1.50	1.975	2.00
10. New steel curb	5,850 l. f.	2.25	1.31	2.75
11. Conc. fndn., pavement	2,200 c. y.	11.50	9.00	6.85
12. Sheet asph. paving, (excl. appr.)	12,700 s. y.	1.33	1.60	1.40
13. Curb redressed and reset	250 l. f.	2.00	1.25	1.50
14. Sheet asph. pav. (adjust. areas)	140 s. y.	1.33	1.60	1.40
15. Concrete sidewalks	2,400 s. f.	.28	.25	.24
16. Public lighting system	L. S.	6,675.00	9,773.00	9,500.00
17. 3½ ft. w.i. fence, (sign W)	1,520 l. f.	4.55	5.48	5.20
18. 3½-ft. fence, (sign T)	120 l. f.	5.25	3.95	6.00
19. 6-ft. fence, used. (sign X)	350 l. f.	2.20	1.35	1.60
20. Concrete curb	1,800 l. f.	.80	.90	1.00
21. Granite block pavmt., with soil joints.	3,870 s. y.	1.45	2.50	1 00
22. Stabil. limestone screen. fndn	180 c. y.	8.70	2.00	6.00
23. Bitum. paving, sidewalk	500 s. y.	.75	1.80	.60
24. Wood and conc. benches	10 ea.	110.00	15.00	150.00
25. Relocate trees	2 ea.	25.00	50.00	35.00
26. Plant new trees	49 ea.	48.00	55.00	55.00
27. Steel reinf., pavmt	13,500 lb.	.10	.12	.10
28. Hexagonal asph block pavmt., used blocks	1,750 s. y.	1.85	2.00	1.50
29. Automatic traffic system	L. S.	3,100.00	4,367.00	5,000.00

BRIDGE, COLORADO

OWNER: Colorado State Highway Department, Denver. Charles D. Vail, State Highway Engineer.

PROJECT: Construction of steel I-Beam bridge with concrete deck across Arickaree River, in Yuma County, south of Wray, Colo., on State Highway No. 51. Consists of 20 spans identical in construction, each 39-ft. long; 25-ft. clear roadway.

CONDITIONS: Quicksand condition exists at bridge site, will require care in handling construction equipment. Materials to be furnished by contractor and project to be finished in 270 consecutive calendar days. Railroad facilities available to Wray, and highway transportation from Wray. Wage rates specified are: skilled, $1.10 per hr.; semi-skilled, 70c.; and common labor, 50c. per hr.

BIDS:—Eleven bids opened September 14, 1939, ranging from the contract low of $78,935 to $88,331. Engineer's estimate, $101,805.

LOW BIDDERS:

1. Lawrence Constr. Co., Denver, Colo. (contract)	$78,935
2. F. M. Kenney, Denver, Colo.	79,279
3. DeRemer & Atchison, Littleton, Colo.	81,250

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Dry common excav., struct	484 c. y.	$0.71	$0.75	$1.50
2. Wet common excav., struct	646 c. y.	4.22	3.00	3.00
3. Selected backfill	80 c. y.	1.56	.50	1.50
4. Untr. bridge timber	0.3 M.b.m.	100.00	80.00	150.00
5. Class A. concrete	1,206 c. y.	19.25	18.00	19.00
6. Class A conc. handrail	73 c. y.	40.00	30.00	35.00
7. Reinforcing steel	163,750 lb.	.0425	.04	.044
8. Structural steel	486,200 lb.	.043	.044	.0475
9. Struct. steel piles	9,310 l. f.	1.85	2.20	1.92
10. Treated timber piles	3,584 l. f.	1.05	1.10	1.10
11. Bronze name plate	1 ea.	25.00	25.00	30.00
12. Sheet copper	675 lb.	.50	.45	.60
13. Drain pipe, 3-in. by 3-ft. 4-in	80 ea.	4.50	4.00	5.00

SEWER RELOCATION CALIFORNIA

OWNER: U. S. Engineer Office, Los Angeles, Calif. Lt. Col. E. C. Kelton, District Engineer.

PROJECT: Relocation of North Outfall Sanitary Sewer due to construction of Sepulveda Flood Control Reservoir. Work located along Victory Blvd. between Balboa and Sepulveda Blvds., and along Sepulveda Blvd. between Victory and Burbank Blvds., Los Angeles, Calif. Work consists of laying 15,900 l.f. of sewer complete with appurtenances. Some manhole frames and covers are to be salvaged from existing sewer, and used in new construction. Sewer to be laid in open trench and/or tunnel.

CONDITIONS: All materials to be furnished by contractor and job must be completed in 210 days. Rail and highway facilities available. Wage rates specified are $1.50 per hr.; semi-skilled, $1.10 per hr.; and common, 62½c. per hr.

BIDS: Thirteen bids were received November 21, 1939, ranging from the lowest acceptable bid, $117,802 to $226,237. A bid of $96,643 was submitted, but it was not accepted. Engineer's estimate, $166,500, includes inspection and overhead.

LOW BIDDERS:

1. Artukovich Bros., Hynes, Calif. (contract)	$117,802
2. John L. Kruly, Los Angeles, Calif.	125,741
3. Culjak & Zelko, Los Angeles, Calif.	133,639

Item	Quan.	Unit Prices (1)	(2)	(3)
1. 24-in. vitr. clay pipe sewer	9,800 l. f.	$6.52	$6.00	$6.70
2. 21-in. vitr. clay pipe sewer	6,200 l. f.	5.00	5.15	6.03
3. 6-in. vit. clay pipe house conn	700 l. f.	1.00	1.30	1.25
4. Chimneys	1,950 l. f.	2.00	3.00	2.00
5. Manholes (48)	L. S.	7,921.00	6,945.00	13,440.00
6. Salv., install m.h. frames, covers	32 sets	5.00	8.00	5.00
7. Manhole frames and covers	16 sets	25.00	25.00	23.00
8. Excav., outside estab. line or grade.	800 c. y.	1.00	1.50	1.00
9. Cr. rock or grav. backfill	500 c. y.	1.25	2.50	2.50
10. Class C concrete	1,400 c. y.	6.00	13.00	17.00

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3
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4
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BAKER

NEW ENGINEERING BOOKS

(*Continued from p. 72*)

A HISTORY OF THE GROWTH OF THE STEAM ENGINE—By Robert H. Thurston. Centennial Edition. 555 pp. Published by Cornell University Press, Ithaca, N. Y.; Humphrey Milford, Oxford University Press, London. Price $3.

GOVERNMENT AND ECONOMIC LIFE—Vol. 1—By Leverett S. Lyon, Myron W. Watkins and Victor Abramson. 519 pp. Published by Brookings Institution, Washington, D. C. Price $3.

PRODUCTION MANAGEMENT—By A. M. Simons. 588 pp. Published by American Technical Society, Chicago. Price $3.50.

REPORTS AND PAMPHLETS

ANAEROBIC FERMENTATIONS—Illinois State Water Survey, Bulletin No. 32. Urbana, Illinois.

ST. FRANCIS LEVEE District, Annual report of Officers of the Board of Directors, 1939.

REPORT OF THE WATER POLLUTION RESEARCH BOARD for 1938, London. May be obtained from the British Library of Information, 50 Rockefeller Plaza, New York City. Price 30c.

MARYLAND MAPPING AGENCY—Third Report. May be obtained from State Planning Commission, Baltimore, Md.

HARTFORD, Conn.—9th Annual Report of the Water Bureau. May be obtained from Metropolitan District Commission, Hartford, Conn.

CHARLESTON, S. C.—22nd Annual Report of the Commissioners of Public Works, Water Dept., 1938.

THE THEORY OF IMPACT TESTING: Influence of Temperature, Velocity of Deformation, and Form and Size of Specimen on Work of Deformation. Reprint from proceedings of American Society for Testing Materials, Philadelphia, Pa.

SETTLEMENT STRESSES IN CONTINUOUS FRAME—Bulletin No. 102. Published by Engineering Experiment Station, The Ohio State University, Columbus, Ohio. Price 40c.

A CORROSAO DOS HIDROMETROS and A CAPACIDADE DE TORCAO DO ITACOLOMITO — Bulletin No. 23 (April). METODOS DE ENSAIOS ADOTADOS NO I.P.T. PARA O ESTUDO DAS MADEIRAS NACIONAIS—Bulletin No 24 (June). Both pamphlets published by Instituto de Pasquisas Technologicas de S. Paulo, Brazil.

PROCEEDINGS OF THE TWENTY FIRST TEXAS WATER WORKS AND SEWAGE SHORT SCHOOL—Texas A. & M. College, College Station, Texas.

NATIONAL PAVING BRICK ASSOCIATION—1939 proceedings of 33rd Annual Meeting. Published by National Paving Brick Association, Washington.

STAHLBETON mit vorgespannten Zulagen aus hoherwertigem Stahl—by Fritz von Emperger. Published by Wilhelm Ernst & Sohn, Berlin, Germany. Price 3.30 RM.

UBER DIE BERECHNUNG SCHIEFER EISENBETONBALKENBRUCHEN — By Robert Seiler. Published by Wilhelm Ernst & Sohn, Berlin, Germany. Price 4.35 RM.

COST OF OPERATING RURAL-MAIL-CARRIER MOTOR VEHICLES ON PAVEMENT, GRAVEL, and EARTH. Bulletin No. 143. Published by the Iowa Engineering Experiment Station, Iowa State College, Ames, Iowa.

RELATED INSTRUCTION FOR PLUMBER APPRENTICES—By Robert W. Hambrook. Published by U. S. Department of Interior, Office of Education. May be obtained from Superintendent of Documents, Washington, D. C. Price 15c.

STUDIES IN REINFORCED CONCRETE—V—Moment Redistribution in Reinforced Concrete. Technical Paper No. 22, Department of Scientific and Industrial Research, London. May be obtained from British Library of Information, 50 Rockefeller Plaza, New York City. Price 40c.

STUDIES IN REINFORCED CONCRETE—VII—The Strength of Long Reinforced Concrete Columns in Short Period Tests to Destruction. Technical Paper No. 24, Department of Scientific and Industrial Research, London. May be obtained from the British Library of Information, 50 Rockefeller Plaza, New York City. Price 25c.

THE NORTHERN LAKES STATES REGION—June 1939. Prepared and Published by the National Resources Committee, Washington, D. C. May be obtained from the Superintendent of Documents, Washington, D. C. Price 10c.

STREAM FLOW RECORDS OF PENNSYLVANIA—For 1937-38. Prepared and published by the Department of Forests and Waters, Division of Hydrography, Harrisburg, Pa., in cooperation with the U. S. Geological Survey.

A YEARBOOK OF RAILROAD INFORMATION (1939 Edition)—Committee on Public Relations of the Eastern Railroads, 143 Liberty St., New York City.

SQUARE SECTIONS OF REINFORCED CONCRETE UNDER THRUST AND NONSYMMETRICAL BENDING—Bulletin No. 14. Published by the University of Minnesota, Engineering Experiment Station, Minneapolis. Price 35c.

STURDY HOME FOR SOFT DRINK

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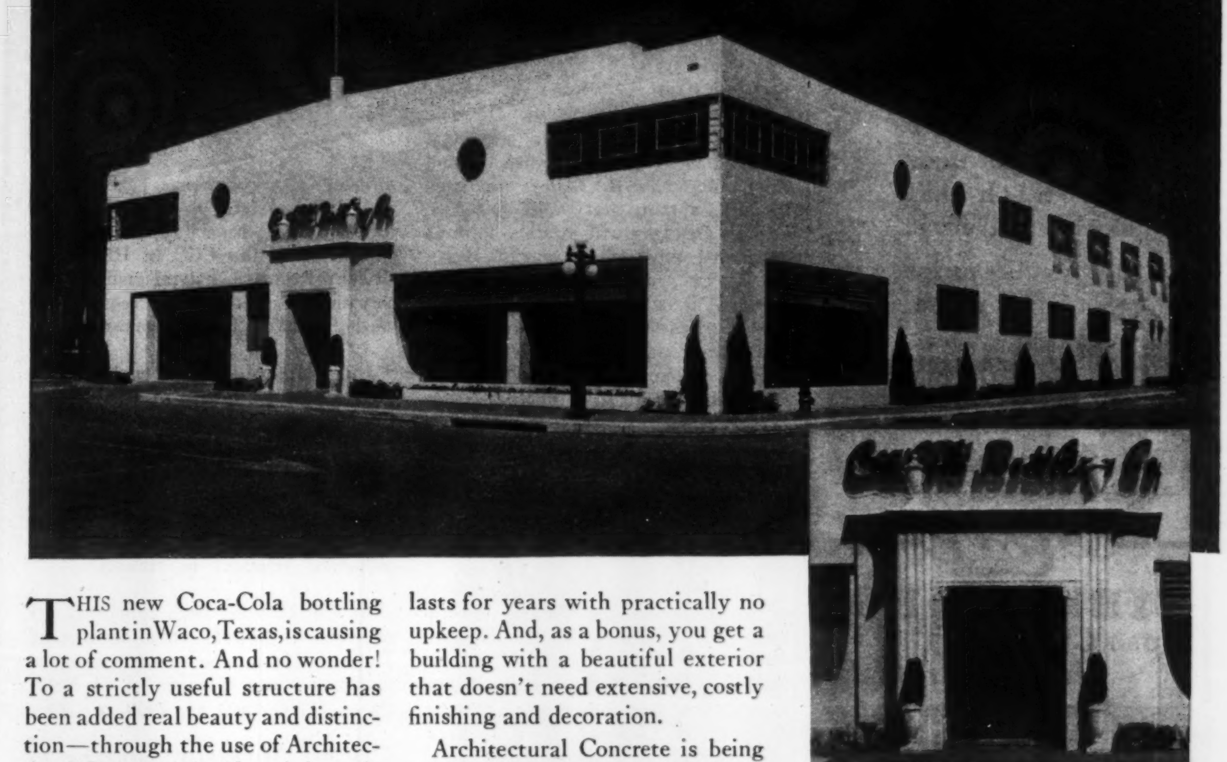

THIS new Coca-Cola bottling plant in Waco, Texas, is causing a lot of comment. And no wonder! To a strictly useful structure has been added real beauty and distinction—through the use of Architectural Concrete. And here it is again Architectural Concrete—made with Universal Atlas cement, plus a finish of light green cement paint made with Atlas White cement. To add to the effect, the surrounding sidewalks are colored with a green pigment.

It will pay you, too, to use this modern form of construction that casts frame, walls, floors, and decorative finish into *one* unit—from *one* thrifty material. You get a fireproof, storm-safe structure that lasts for years with practically no upkeep. And, as a bonus, you get a building with a beautiful exterior that doesn't need extensive, costly finishing and decoration.

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BUILD WITH CONCRETE

Main Picture: New Coca-Cola bottling plant in Waco, Texas. It's built with Architectural Concrete made with Universal Atlas Cement. Light green cement paint made with Atlas White cement on exterior. Sidewalks colored with green pigment. Architect, Robert V. Darrah, Los Angeles. Associate Architect, T. Brooks Pearson, Waco. General Contractor, C. C. Ramsey, Waco.
Insert: A detail of the clean, modern design achieved with Architectural Concrete.

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Write for full information.

MALL TOOL COMPANY
7730 SOUTH CHICAGO AVENUE CHICAGO, ILLINOIS

(News continued from page 33)

MEN AND JOBS

Stanley R. Biesack, graduate of the University of Cincinnati in 1939 with the degree of civil engineering, is now employed by TVA in location of highways and bridges for the Gilbertsville Dam and reservoir work at Gilbertsville, Ky. While attending the University of Cincinnati, Biesack worked in the division of highway maintenance, City of Cincinnati, and after graduation for a time with the Cincinnati water works department.

Capt. Paul D. Berrigan, former officer of the North Pacific Division, U. S. Engineers, has been appointed head of the engineering division and Capt. Benjamin B. Talley appointed to fill Captain Berrigan's old post. Captain Berrigan will continue to serve as an executive officer to **Col. John C. H. Lee**, division engineer. That **Lieut. Frank S. Besson** will leave the latter part of this month to begin new duties at Fort Belvoir, Va., is another change announced at the North Pacific office.

Mac D. Saxon, Jasper, Ala., has been appointed director of the WPA employment division in Alabama. W. G. **Henderson** is Administrator for the WPA in Alabama.

T. B. **McQueston**, Toronto, minister of highways for the Ontario government and chairman of the Niagara Falls Parks Commission, was elected chairman of the Niagara Falls Bridge Commission, Dec. 8 to succeed **Samuel N. Johnson**, Lockport, N. Y. C. **Ellison Kaumeyer**, Niagara Falls, Ont., was reelected secretary.

C. R. **Pennington**, Abilene, Tex. has been elected chairman of the board of directors of lower Colorado River authority to succeed Fritz Engelhard of Eagle Lake. Clarence McDonough, general manager and Max Starcke, operating manager, continue in their present posts.

Augustin V. Lopez, Manuel de la Torre Diaz and **Francisco J. Orozco**, Mexican civil engineers, are in charge of the survey being carried out for a railroad between Mexicali, Lower California territory, and Santa Ana, Sonora state.

William Bowie has been elected executive secretary of the Society of American Military Engineers and Editor of *The Military Engineer*, the journal of the society. Bowie, who holds degrees from Lehigh University, Trinity College, George Washington University and Edinburgh University, is a holder of the grand prize of the Academy of Sciences in Belgium, the Cresson Medal by Franklin Institution. He was made commander of the Order of Orange Nassau by the Queen of Netherlands in 1938 and in 1939 was awarded the Bowie Medal by the American Geophysical Union. He is a former chief of the Division of Geodesy, United States Coast Geodetic Survey, having retired from that position in 1937.

E. A. **Pesonen**, assistant regional director of the national park service with headquarters in Santa Fe, New Mexico, has been appointed field supervisor of the CCC in Hawaii by **Robert Fechner**, federal civilian conservation corps director. Pesonen succeeds **Everett Tillet**, who resigned.

John M. Young, civil engineer and graduate of University of Florida and Cornell University, and now president of the Pacific Engineering Co. and professor of engineering at the University of Hawaii, has been appointed one of five members of the newly formed territorial commission of labor and industrial relations in Hawaii.

Ed Choteau has been appointed city manager of Nowata, Okla. to succeed **John O. Hall**, who recently resigned to become city manager of El Reno, Okla. (*ENR* Dec. 14, 1939, p. 799).

Jardine MacKerlie, managing director of the Industrial Training Systems, Toronto, has been named engineer for the Department of Transport of Ottawa.

Howard Williams, assistant project engineer of the state WPA quarters at Jefferson City, Mo., has been named temporary director of fourteen Missouri counties.

C. S. **Leary** has been appointed minister of public works and railways for the Province of British Columbia. He succeeds F. M. **MacPherson**, who has been nominated to the dominion board of transport commissioners.

Harry Racer, engineer for Tama county, has resigned and is now associated with R. L. **Anderson**, contractor of Cedar Rapids, Iowa.

James F. Dwyer, Jr. has been re-

SEASONS GREETINGS

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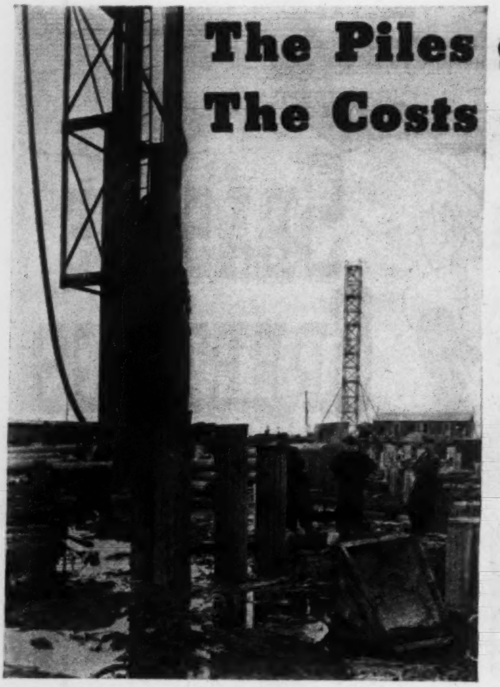

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UNION HAMMERS

When it comes to piles like these big steel shells you want speedy, trouble-free hammer operation. Unions are built for driving modern long, heavy piles. That means simple, strong hammer construction. They embody heat-treated alloy steels, nickel semi-steel alloy bronzes, etc., in a design based on many years of experience. One piece frame; no bolts in moving parts; few parts; economy of steam or air consumption.

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Big Savings

ON TOUGH EXCAVATING

Sauerman Slackline Cableway used for placer mining in South American jungle.

WHEREVER there is a job of digging sand and gravel, making long cuts and fills, cleaning out ponds, building dams or levees, stockpiling, and similar work involving long hauls—it pays to find out what a Sauerman Slackline or Drag Scraper will do and what it will cost. Generally a Sauerman machine will handle these jobs and similar problems of moving materials to a hopper or fill at a lower cost than other types of equipment.

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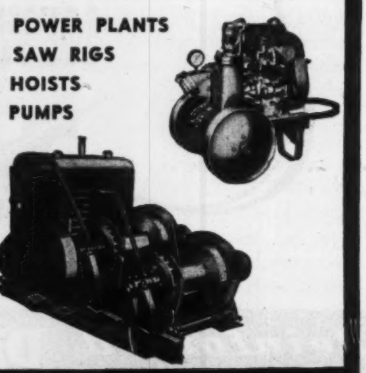

Sterling
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appointed superintendent of streets and Edward J. Maley as superintendent of sewers for New Haven, Conn. Their appointments are for two years.

R. A. Sutherland, assistant resident engineer on the Yampa Irrigation District, Colorado, is now working with the Harza Engineering Co., Chicago. Previous to going on the Yampa work, Sutherland was working on the Tri-County project in Nebraska.

MEETINGS

American Shore and Beach Preservation Association, annual meeting, Hotel Carlton, Washington, D. C., Jan. 10.

National Air Conditioning Association, first annual convention, Hotel Stevens, Chicago, Ill., Jan. 15-17.

Canadian Construction Association, Royal York Hotel, Toronto, Ont., Jan. 16-17.

American Society of Civil Engineers, annual meeting, New York City, Jan. 17-19.

American Society of Planning Officials, Chicago, Ill., January 18-19.

National Crushed Stone Association, Hotel Jefferson, St. Louis, Mo. Jan. 22-24.

National Society of Professional Engineers, Cincinnati, Ohio, Jan. 25-27.

National Public Housing Conference, Washington, D. C., Jan. 26-28.

American Road Builders Association, Chicago, Jan. 29-Feb. 2.

National Paving Brick Association, annual meeting, Congress Hotel, Chicago, Ill., Jan. 30-31.

REGIONAL AND LOCAL

American Water Works Association, New York Section, winter meeting, Commodore Hotel, New York City, Dec. 28.

County Commissioners Association of North Dakota, annual convention, Bismarck, Jan. 9-11.

Associated American General Contractors, Central Branch, annual convention, Des Moines, Iowa, Jan. 10-11.

Kansas Contractors Association, Kansas City, Mo., Jan. 11-12.